HILL, ALLA, Ph.D. Examination of the Biobehavioral Effects of Food Insecurity by Investigating its Relationship to Changes in the Household Food Supply and Food Reward Sensitivity. (2020)
Directed by Dr. Jigna M. Dharod. 172 pp.

Research has found a paradoxical relationship between food insecurity and increased obesity, which disproportionately affects low-income women. The relationship between food insecurity and obesity is mediated by diet quality where food insecurity has a negative effect on overall diet quality, promoting excess energy intake and subsequent weight gain. Some research indicates that there may also be intra-monthly changes in diet quality and food availability among women in food insecurity.

Thus, the goal of this research was to understand the extent by which the availability of a variety of foods, a critical component of food insecurity, occurs at the household level and how it affects dietary intake patterns and liking for palatable foods. The objectives were to: 1) examine associations between food insecurity and monthly changes in variety of food available at the household level, 2) examine associations between food insecurity and changes in diet quality at a monthly level, 3) determine associations between food insecurity and food reward sensitivity using self-reported and brain fMRI scan assessments.

A cross-sectional exploratory research study of 13 low-income adult women was conducted to address these objectives. Participants completed two telephone interviews and two brain Magnetic Resonance Imaging (MRI) scans in the beginning and end of month periods based on their typical monthly income cycles.

Food insecurity was prevalent among participants (69%). Participants reported a low variety of fresh fruits and vegetables at both interviews, and the variety of these declined from the beginning to the end of month period. Overall diet quality was poor among participants, with an average HEI-2015 score of 45.2 in the beginning of the month and 50.8 in the end of the month compared to the maximum possible score of 100. Analysis of functional MRI (fMRI) results demonstrated the feasibility of using functional neuroimaging techniques to evaluate individual differences in brain activation for palatable and healthy food images among participants.

These findings suggest low-income women experience intra-monthly changes in variety of food available in the household and individual diet quality. And, investigations of intra-monthly changes in the home food environment, diet quality, and fMRI activation for visual food stimuli are important for understanding the relationship between food insecurity and obesity among low-income women. This work contributes to a greater understanding of the biobehavioral effects of food insecurity, which influence dietary intake and ultimately nutrition related health outcomes in those experiencing food insecurity.

EXAMINATION OF THE BIOBEHAVIORAL EFFECTS OF FOOD INSECURITY BY INVESTIGATING ITS RELATIONSHIP TO CHANGES IN THE HOUSEHOLD FOOD SUPPLY AND FOOD REWARD SENSITIVITY

by

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A Dissertation Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
2020

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03/11/20
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ACKNOWLEDGEMENTS

I would like to thank my advisor Dr. Jigna Dharod for her guidance and support throughout my doctoral degree program. I would also like to thank the members of my committee, Dr. Danielle Nunnery, Dr. Steve Fordahl, and Dr. Lauren Haldeman for their support, direction, and assurance throughout this process. My success would not have been possible without the unwavering support and continuous encouragement from my parents, Jerry and Melanie Hill. Thank you to Jay, Kelsey, and Roger for never doubting me and building me up when I needed it most. I got by with a lot of help from my friends Sami Strickland and Meg Lawless, thank you for editing my drafts all these years. Lastly, I would like to extend my sincerest thanks to the women who gave their time and effort as participants in this research project.

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CHAPTER I

INTRODUCTION

Low-income women in the U.S. are disproportionately affected by the obesity epidemic and suffer from higher rates of associated chronic diseases than their higher-income counterparts. Low-income adult women are also more vulnerable to experiencing food insecurity, which further increases the likelihood of poor diet quality and nutrition related health outcomes (Coleman-Jensen et al., 2019; Gundersen & Ziliak, 2018). The literature suggests that poor diet quality in food insecurity is a result of financial constraint, where food purchases are strongly impacted by financial resources available and food cost per-calorie (Aggarwal et al., 2011; Darmon & Drewnowski, 2015). And as energy-dense, nutrient-poor foods are more affordable than nutrient-dense low-energy foods, it follows that such foods would be prioritized among those experiencing food insecurity. Nutrition research has found that typical diet patterns in food insecurity are lacking in foods such as fresh fruits, vegetables, and whole grains which are promoted in a healthy diet (Hanson & Connor, 2014; Leung et al., 2014; Taylor et al., 2017). A study investigating differences in diet patterns of U.S. adults participating in the National Health and Nutrition Examination Survey (NHANES) from 2005-2012 found significant differences in overall diet quality by food security status (Taylor et al., 2017). When compared to diet patterns of food secure adults, food insecure adults had poorer

diet quality, lower intake of fruits and vegetables, a greater proportion of energy, carbohydrate, and fat intake from energy-dense grain dishes, and greater intake of sweetened beverages, high-fat protein foods, and milk and dairy products (Taylor et al., 2017). However, previous research on food insecurity and dietary habits among low-income women in particular has produced inconsistent results. For example, in our previous study of low-income pregnant women, although 44% were experiencing moderate to severe levels of food insecurity, we found no significant differences in the relationship between food insecurity and diet quality (Hill et al., 2019). However, in mediation analyses it was found that by affecting the home food environment, food insecurity exerted an indirect influence on daily food intake. Specifically, food insecurity was associated with lower availability of fruits and vegetables at home, which in turn was associated with decreased intake of fruits and vegetables. Thus, the framework for studying the relationship between food insecurity and obesity is guided by the two proposed pathways of decreased diet quality and obesogenic food environment.

A critical aspect of food insecurity is the experience of disrupted eating patterns and inconsistencies in the availability of foods. In practice, disrupted eating patterns may be observed in individuals who skip meals when food is less available, and over-consume during times when food is more plentiful. Previous research has identified specific time periods where this is more likely to occur, termed the 'feast and famine cycle' in food insecure individuals, where diet and eating behaviors fluctuate according to individual benefits receipt and cyclical pay periods (Dinour et al., 2007; Sanjeevi & Freeland-Graves, 2019; Whiteman et al., 2018). In this cycle, the 'feast' period describes

individuals' dietary patterns when they have first received assistance benefits or income. During this time, overall diet quality is more adequate, and individuals have greater access to a variety of foods. However, as the time since receipt of income increases, diet quality and availability concurrently decrease. Peaking in the 'famine' period where resources are markedly lower, and both availability and variety in food is poor, and diet quality is suboptimal. These experiences persist until the cycle begins again in the next 'feast' period. Though, research investigating the relationships between food insecurity, diet quality, and food availability as they pertain to the monthly resource cycle remains a gap in the literature.

Further, food insecurity is posited to elicit biobehavioral and physiological effects in individuals which may compound their increased risk for poor diet quality and nutrition related health outcomes. The resource scarcity, inconsistency, and stress of food insecurity are believed to negatively affect individual cognitive capacity for regulating food choices and eating behaviors, predisposing food insecure individuals to poor nutrition (Laraia et al., 2017). Food insecurity is associated with decreased environmental access to the fresh fruits and vegetables and other foods which comprise a healthy diet. Individuals experiencing food insecurity are more likely to live in obesogenic areas where physical access to these foods is limited and access to energy-dense and highly palatable foods is ubiquitous. In general, highly palatable foods are described as being energy-dense and also containing ingredients such as fat, sugar, and sodium, which increase the palatability of the food (de Macedo et al., 2016; Sinha, 2017). While researchers have yet to reach consensus on defining the term, *Fazzino et al.* propose

defining hyper-palatable foods as those which "contain combinations of palatability-inducing ingredients, fat, sugar, carbohydrates, and/or sodium, at moderate to high levels that may circumvent physiological satiety mechanisms and activate brain reward neural circuitry (Fazzino et al., 2019). They further distinguish that foods which contain only one palatability-inducing ingredient such as raw fruit or unsalted nuts would not be considered hyper-palatable as they contain satiety-inducing nutrients like fiber and do not influence neural reward processing. *Fazzino et al.* defined three groupings of hyper-palatable foods based on nutrient content: 1) >25% kcal from fat and ≥0.30% sodium by weight, 2) >20% kcal from fat and >20% kcal from sugar, and 3) >40% kcal from carbohydrate and ≥0.20% sodium by weight (Fazzino et al., 2019). Neuroscience research investigating the significance of highly palatable foods has found that the presence of these foods elicits a strong dopamine response in the nucleus accumbens, a major component of the mesolimbic reward and motivation pathway in the brain (Erlanson-Albertsson, 2005; Lutter & Nestler, 2009). Thus, the activation of the neural reward system in response to highly palatable food cues and food consumption may result in an increased desire or motivation to consume such foods (Lowe & Butryn, 2007). This presents a unique problem in the obesogenic food environment, where food insecure individuals have relatively greater access to highly palatable foods. And, a heightened individual physiological response for highly palatable foods may negatively influence food choices and result in increased consumption of these foods.

Moreover, food insecurity is significantly associated with increased chronic stress, which is linked to excessive intake of palatable food and weight gain (Adam &

Epel, 2007; Groesz et al., 2012; Torres & Nowson, 2007). Combined with the stress and anxiety of food insecurity, the food environment may predispose food insecure individuals towards choosing more energy-dense foods by nature of their palatability and lack of access to alternative nutrient-dense options. Consequently, investigating the relationships between food insecurity, diet quality, and eating patterns from a biobehavioral perspective is important for mitigating the effects of stress and the obesogenic food environment on weight outcomes.

The overall goal of this research was to examine the association of the home food environment, diet quality, and food reward sensitivity within the feast and famine cycle among low-income women. The specific objectives were to: 1) investigate variety of the home food environment in the beginning and end of the month, 2) investigate overall diet quality and stress among women in the beginning and end of the month, and 3) explore the feasibility and importance of using fMRI methods to assess neural activation for food stimuli among low-income women within a month.

CHAPTER II

REVIEW OF THE LITERATURE

Food Insecurity

Food insecurity is a major public health problem in the United States (U.S.) and is defined as, "the limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (Anderson, 1990). Prevalence and severity of household food insecurity in the U.S. is monitored through the Census Bureau's Current Population Survey Food Security Supplement (CPS-FSS) and is reported annually by the Economic Research Service (ERS) of the United States Department of Agriculture (USDA). Households which are categorized as food insecure may be further divided into low or very low food security status. While the national rate of food insecurity has decreased in recent years, it remains a prevalent public health problem.

According to the USDA report on Household Food Security in the US in 2018, approximately 14.3 million households (11.1%) were food insecure (low to very low food security) at some point during the year, and specifically 5.6 million (4.3%) households had very low food security (Coleman-Jensen et al., 2019). As depicted in the definition, food insecurity is a multi-dimensional construct which encompasses not only the overall amount of food available, but also assesses anxiety or worry over food, and disrupted eating patterns such as skipping meals or not eating for a whole day. Distinctions

between low and very low food security are made based on the extent to which interruptions in food supply are experienced within a household or for an individual, and the severity of impact these interruptions have on diet quality, anxiety and overall intake. In terms of severity of food insecurity, individuals who are categorized as low food security typically experience some anxiety about food or the food supply and may experience reduced overall diet quality, but not necessarily hunger. Individuals categorized as very low food security may experience increased anxiety about food or the food supply, disrupted eating patterns, decreased diet quality, and an overall reduced intake of food or hunger.

From an economic perspective, lower total household income is a major determinant of food insecurity, but its influence may be mediated by the presence of other assets which may protective against food insecurity in the case of low-income (Gundersen & Ziliak, 2018). For example, lower financial management skills, level of education, financial assets such as decreased savings and access to credit, and less physical property assets may further increase risk of food insecurity for low-income people, but any improvement to these assets may serve to stave off the effects of income on food security (Gundersen & Ziliak, 2018). Still, low-income groups are highlighted consistently across the literature as at-risk for food insecurity and in 2018, the majority of food insecure households (54.5%) had incomes <185% of the poverty threshold (in 2018 the line was $25,465 for a family of two adults and two children) (Coleman-Jensen et al., 2019). Demographic analyses also show that certain groups report higher rates of food insecurity than the national average and thus are more vulnerable to experiencing food

insecurity than others such as, all households with children, households with children under 6 years, households of women or men living alone, households with children headed by a single woman or man, households with Black non-Hispanic and Hispanic heads of household (Coleman-Jensen et al., 2019). Although both single men and women living with children have higher incidences of food insecurity, the gender differences in these rates indicate women experience an even greater burden of low food security (18.4%) and very low food security (9.4%) when compared to single men (10.6% low food security, 5.3% very low food security) (Coleman-Jensen et al., 2019). Geographically, the prevalence of food insecurity in the Southern region of the U.S. (12.0%) is significantly higher than the national average, and higher than in any other region of the country. Consequently, adult single women, living alone or with children, who are racial/ethnic minorities, and residing in the South, are an intersectional group uniquely susceptible to experiencing food insecurity and its associated consequences.

Epidemiological research in the U.S. has found that food insecurity is associated with numerous adverse health outcomes, including the development of hypertension, type II diabetes mellitus, nonalcoholic fatty liver disease, and cardiovascular disease (Golovaty et al., 2019; Seligman et al., 2007, 2009; Seligman & Schillinger, 2010). Food insecurity is also associated with an increased risk of overweight and obesity for low-income Americans, especially this paradox of food insecurity and obesity is consistently seen among low-income women (Laraia, 2013). During pregnancy, food insecurity has been linked with increased levels of stress, disordered eating, higher gestational weight gain, increased risk for gestational diabetes mellitus, and greater postpartum weight

retention (Laraia et al., 2015; Laraia et al., 2011). Among children, food insecurity is associated with increased risk for anemia, cognitive problems, lower nutrient intakes, depression, anxiety, higher risks of hospitalization, aggression and behavioral problems, asthma, poor oral health, and poorer overall health (Gundersen & Ziliak, 2015). For adults, food insecurity is associated with decreased nutrient intakes, poor overall diet quality, higher rates of mental health problems, disordered eating behaviors, stress, depression, poor sleep, dyslipidemia, and inflammation (Becker et al., 2017; Gowda et al., 2012; Gundersen & Ziliak, 2015; Hanson & Connor, 2014; Heflin et al., 2005; B. Laraia et al., 2015; Leung et al., 2014, 2015). Among senior adults, food insecurity is associated with lower nutrient intakes, poor or fair overall health, medication underuse, depression, and limits in activities of daily living (Afulani et al., 2015; Bengle et al., 2010; Gundersen & Ziliak, 2015; Sattler & Lee, 2013). Therefore, research has demonstrated that food insecurity negatively influences physical and mental health and well-being across the lifespan.

As food insecurity is a condition which directly influences an individual's ability to maintain adequate nutritional status, understanding the etiology of nutrition-related diseases among food insecure individuals may seem straightforward. However, the paradoxical positive relationship between increased severity in food insecurity and increased incidence of obesity demands a closer assessment of the mechanisms involved. In examining the paradox of obesity and food insecurity among low-income women specifically, two significant pathways have been noted in the literature.

For one, low-income food insecure women may demonstrate poor diet quality as a direct result of financial resource constraints. As a direct result of financial constraints on household income and food budget, low-income women rely more on cheaper food options, which are generally high in calories, saturated fat, sugar, and sodium. Specifically, food cost has been shown to mediate the influence of socioeconomic status on diet quality. Demonstrating that the actual cost of food itself is a contributor to inequalities in diet quality (Aggarwal et al., 2011; Darmon et al., 2005; Darmon & Drewnowski, 2015; Maillot et al., 2007). As low-income individuals experience financial strain, their overall purchasing power and ability to obtain adequate nutrient-dense foods to support nutritional health is reduced. Consequently, in order to meet overall caloric needs and operate within a tight budget, behavioral economics of food choice among low-income food insecure adults shows trends of reliance on cost-effective foods with a greater overall energy-density, which may also be high in total and saturated fat, sodium, and sugar (Maillot et al., 2007). A systematic review analyzing the economics of food cost and diet quality found that healthier diets, which are comprised of a variety nutrient-dense and acceptable foods, tend to have a greater cost per-calorie than less-healthy diets, which are more energy-dense and have a lower cost per-calorie (Darmon & Drewnowski, 2015). Thus, the higher cost of nutrient-dense foods deters low-income individuals from purchasing these in the marketplace, whereas the more accessible energy-dense food options provide a greater amount of energy at a more affordable price. The consistent overconsumption of these foods in a dietary pattern displaces foods with higher nutrient-density which have a more favorable unsaturated to saturated fat ratio, lower total fat,

sodium, and sugar such as whole grains, fruits, vegetables, legumes, and low-fat dairy resulting in overall poor diet quality. While national dietary guidelines promote the consumption of specific foods and eating patterns to promote health, research has shown that the actual cost of purchasing such foods to adhere to recommendations is practically impossible for most low-income individuals (Horning & Fulkerson, 2015). The prohibitive higher cost of foods more commonly associated with a higher quality dietary pattern is a significant barrier for low-income individuals in achieving adequate diet quality. The USDA National Household Food Acquisition and Purchase Survey (FoodAPS) analysis of food purchase quality among low-income households found that food insecure households both spend less on food and are more likely to purchase no whole or total fruit, no seafood or plant protein foods, no dairy or total protein foods, and to purchase excess refined grains within a week when compared to food secure households (Gregory et al., 2019). Thus, the coexistence of overweight and obesity among low-income adults, and specifically women, is partially explained by the excess energy intake resultant from an overreliance on energy-dense foods, leading to positive energy balance and excessive weight gain.

The second major pathway of the food insecurity and obesity paradox is also explained by the role of the overall food environment as a major determinant of food choices, nutrient intake, and subsequent energy balance. Broadly, the food environment encompasses the social and built environments which, in the context of nutrition, influence access to affordable and healthy foods (Glanz et al., 2005). Research on the influence of the food environment on nutrition most commonly evaluates the degree of

impact on individual dimensions of food access. Whereas food access describes not only the physical accessibility of nutritious foods but also includes the dimensions of affordability, availability, acceptability, and accommodation, an individual may experience reduced food access via limitations on any one dimension (United States Department of Agriculture, 2009; Caspi et al., 2012; Penchansky & Thomas, 1981). Factors such as increased travel time to obtain food or inadequate transportation are both indicators of decreased physical accessibility. Food access may be negatively impacted by a lower availability of nutritious foods in the environment, an increase in the price of those foods, or a perception of that the foods available are unacceptable based on personal or cultural standards (Caspi et al., 2012). Finally, whether or not food sources accommodate consumers' needs also contributes to an individual's food access in the local food environment.

Environmental assessment studies indicate that low-income individuals experience significantly greater barriers to accessing nutritious foods, such as fruits and vegetables, than those with higher incomes (Baker et al., 2006). The FoodAPS study found that when shopping for foods for the home, food insecure households spent significantly more money on food purchased at convenience stores ($7.46 vs. $3.42, $P<0.1$) and less money on food purchased at supermarkets or grocery stores than food secure households in a week ($14.36 vs. $23.90, $P<0.01$) (Gregory et al., 2019). These findings are due in part to the reduced access that low-income people have to traditional supermarkets or grocery stores which typically have greater availability of a variety of high-quality foods for the most affordable price (Larson et al., 2009). Indeed,

geographical analysis across the U.S. has demonstrated that low-income and racial/ethnic minority individuals are more likely to reside in areas referred to as "food deserts" — geographic locations marked by a lack of supermarkets and grocery stores within one mile (United States Department of Agriculture, 2009; Baker et al., 2006; Larson et al., 2009). Not only are low-income and minority individuals disadvantaged in access to healthy or more nutritious foods, they may also have disproportionate access to energy-dense, high-fat, and high-sugar foods. In this respect, both groups are more likely to live in areas known as "food swamps" where fast food restaurants and 'junk food' outlets, such as convenience stores selling energy-dense foods, inundate other healthy alternatives in the environment (Cooksey-Stowers et al., 2017; Fleischhacker et al., 2011; Larson et al., 2009; Rose et al., 2009). In addition to low-income adults' existing issues with accessing nutrient-dense foods, they are also flooded with external cues and opportunities to purchase and consume highly palatable foods in the obesogenic food environment (Cohen et al., 2010; Nansel et al., 2016; Watson et al., 2016). Highly palatable foods are by definition energy-dense, consisting of high-fat and high-sugar content, making them less satiating which promotes their frequent overconsumption (Sinha, 2017). Thus, this combination of living in areas with both decreased access to nutritious foods and increased access to less nutritious foods has been associated with poor diet quality and an increased risk for obesity (United States Department of Agriculture, 2009; Cooksey-Stowers et al., 2017).

The Home Food Environment

The relationships between food insecurity and increased incidence of overweight and obesity are frequently purported to be explained by the two major pathways of financial constraints on food choice and limitations of food access. However, it is not clear how the chronic inconsistency in availability of food, a critical component of food insecurity, affects diet quality and health outcomes. Indeed, the USDA distinguishes that among households experiencing very low food security, instances of reduced intake and disrupted eating patterns are typically recurrent within in a year but not necessarily constant on a daily basis (Coleman-Jensen et al., 2019). For instance, from mid-November to mid-December 2018, the actual average daily prevalence of very low-food security in that period varied between 0.8-1.0 million households, much lower than the annual prevalence of 14.3 million (Coleman-Jensen et al., 2019). Therefore, it can be concluded that food insecurity by nature is a cyclical phenomenon, where individuals and households oscillate between periods of both adequate access to food and severely inadequate access at multiple points throughout a year (Seligman & Schillinger, 2010). This is critical as food scarcity, hunger, and deprivation have been shown to increase the reinforcing value of food and may bias brain reward systems towards more palatable and energy-dense foods (Goldstone et al., 2009). Even among animals, studies show that variable access to food increases food cravings and high sensitivity to food cues (Coplan et al., 2001, 2005, 2006).

Although federal supplemental nutrition programs aim to alleviate some financial constraints associated with food insecurity and diet quality, many participants are

challenged to maintain consistency in their food supply in accordance with the monthly benefit distribution schedule. Evidence on low-income households' food spending patterns indicates that food insecurity and inconsistency of food in the home may be following a monthly pattern of sufficiency and scarcity (Dinour et al., 2007; Hamrick & Andrews, 2016; Wilde & Ranney, 2000). The benefit redemption data of the Supplemental Nutrition Assistance Program (SNAP), the largest (both in terms of number of participants and overall expenditure) food assistance program for low-income and food insecure households, indicates that the average household spends 59% of the benefit within the first week of issuance (Castner & Henke, 2011). As the month continues, the remittance data shows that benefit spending is limited and 90% of households have spent the total benefit amount by the beginning of week 3, leading to an increased likelihood of experiencing a food shortage at the end of the month (Castner & Henke, 2011). This flux of household resources in relation to purchasing and consumption patterns has been described as a "feast and famine" cycle in low-income households (Althoff et al., 2016; Damon et al., 2013; Hamrick & Andrews, 2016; Lin et al., 2013; Tarasuk et al., 2007). The "feast" part of the cycle occurs within the one- to two-week period directly after person receives their monthly assistance benefits payment, resources within the household are high, and food is more available. Hence, the "famine" period of the cycle describes the decline in available resources resulting in a decline in total energy intake thereafter (Sanjeevi & Freeland-Graves, 2019; Tarasuk et al., 2007; Wilde & Ranney, 2000). In some cases, the famine period may even include entire days without eating. An analysis of time diaries in the American Time Use Survey Eating and Health Module

found that SNAP participants were more likely to report not eating for a day over the course of the monthly benefit cycle when compared to low-income non-SNAP participants and high-income participants (Hamrick & Andrews, 2016). A study investigating monthly dietary patterns of low-income Canadian women, showed that those experiencing food insecurity exhibited significant declines in consumption of total energy, carbohydrate, vitamin B_6, fruits, and vegetables from the date of assistance benefit receipt to the end of the month (Tarasuk et al., 2007). In a study of 151 low-income women participating in SNAP in Central Texas, where diet quality was assessed four times throughout a month, overall diet quality was found to be significantly lower in the end of the month compared to the first and second week of the month when SNAP was disbursed (Sanjeevi & Freeland-Graves, 2019). However, when the interaction between time and food security status on diet quality scores was assessed, the results were nonsignificant suggesting that the decline in diet quality scores were independent of food security status in this study.

In our previous study with low-income pregnant women, it was found that food insecurity was associated with lower availability of fruits and vegetables at home, and this in turn mediated the relationship between FI and lower intake of fruits and vegetables (Hill et al., 2019). The limited number of studies utilizing multiple intra-monthly measures of home food availability in food insecure households demonstrate that these food environments are highly variable in terms of variety and amounts of foods present within a month (Sharkey et al., 2010; Sisk et al., 2010). A pilot study utilizing five in-home assessments of the home food environment found the weekly presence of fresh

fruits to be least consistent among very low food secure households, and the presence of fresh vegetables was inconsistent in both very low food secure and food secure households (Sisk et al., 2010). The home food environment of food insecure households is sensitive to the depletion of food assistance benefits and overall income within a month which is evidenced by a reduction in overall food purchasing, increased instances of not eating, decreased energy intake, and reduced variety of foods available. However, little is known about how the inconsistency in food availability in the home food environment influences food choices, overall diet quality, and the potential health risks for adult women experiencing food insecurity.

Biobehavioral Pathways

Beyond the established influences on food security status and purchasing power, it is proposed that inconsistent access to food in food insecurity can also affect food choices and health through biobehavioral pathways. *Laraia et al*. describes the biobehavioral theory of health as, "a complex interplay between social and environmental exposures and human biological responses, which change and shape behavior" (Laraia et al., 2017). The biobehavioral theory of health explains how the compounded environmental influences of poverty –employment, housing, and food insecurities– can affect the physiological response mechanisms associated with cognition, sleep, reward, and stress for low-income individuals (Laraia et al., 2017; Committee on Health and Behavior, 2001). The multiple burdens of poverty creates stress and emotional responses, which are regulated by the nervous, endocrine, and immune systems, and may negatively influence health behaviors and dietary choices that increase risk of overweight and

obesity (Baum et al., 1999; Institute of Medicine, 2001; Hemmingsson, 2014; Laraia et al., 2017).

Food Reward Sensitivity

Food reward sensitivity describes the individual differences in the neurological processing of food stimuli as rewarding (Appelhans et al., 2011; Cheval et al., 2017). When a person consumes a highly palatable food or is exposed to food stimuli through sight or smell, they experience response activation in the reward and somatosensory regions of the brain that encode the sensory and hedonic aspects of food (Cheval et al., 2017; Farr et al., 2016; Goldstone et al., 2009; Stice et al., 2008). The chronic perceived stress observed in low-income groups, including persistent experiences of food insecurity, may be a significant determinant of individual food reward sensitivity (Baum et al., 1999; Laraia, 2013). Physiological activation of the hypothalamic-pituitary-adrenal (HPA) axis in the chronic stress response initiates the release of the hormone cortisol which increases appetite and motivation to consume highly palatable energy-dense foods. For women experiencing food insecurity, this chronic stress response may lead to dysregulated eating behaviors and coping strategies which promote a positive energy balance, excess weight gain, and abdominal fat accumulation (Laraia et al., 2017; Zellner et al., 2006). In one study of low-income women participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), increased perceived stress was associated with unhealthy eating behaviors, obesity, uncontrolled eating, and emotional eating (Richardson et al., 2015). Additionally, the chronic stress experienced by food insecure individuals influences specific hormones and peptides

which increase motivation and liking of highly palatable foods, and thus increase food reward sensitivity (Sinha, 2017; Torres & Nowson, 2007). A neuroimaging study of adult women found that for those reporting high chronic stress, the images of high-calorie foods resulted in greater activation in regions of the brain involving reward, motivation, and habitual decision-making, and significant deactivation in the regions of executive control (Tryon et al., 2013). Evidence suggests that the experience of chronic stress may alter brain activation for food stimuli which predisposes an individual for overconsumption of palatable foods or "comfort foods", by increasing their reward value, and reducing the individual's ability to exercise restraint in response to palatable food cues. For a low-income adult experiencing chronic stress, inconsistency in food availability, and living in an obesogenic environment, these biobehavioral pathways may amplify the negative impact of food insecurity on eating behaviors and food choices. Additionally, chronic stress-related activation of the HPA axis has also been associated with increased insulin resistance and visceral fat accumulation over time, further increasing an individual's risk for excess weight gain and diet-related chronic diseases (Adam & Epel, 2007; Laraia et al., 2017; Seligman & Schillinger, 2010).

Adults experiencing food insecurity, particularly women, are uniquely susceptible to making poor quality food choices. First, inconsistency in food availability might cause high levels of stress, which in turn, may influence individual eating behaviors and initiate compensatory mechanisms to maintain energy balance in response to periods of deprivation. SNAP redemption data and other studies indicate that the availability of food at the household level is likely to be inconsistent in food insecure and low-income

households. Studies also show that inconsistency in access to food is associated with stress, but there is a lack of evidence estimating the inter-relationships between inconsistency in home food availability, stress, and sensitivity of brain activation for food stimuli. Thus, this research examines the association of these factors using the food assistance monthly cycle model investigating home food availability, food reward sensitivity and diet quality among women experiencing food insecurity.

CHAPTER III

MEASURING INTRA-MONTHLY CHANGES IN THE VARIETY AND CONSISTENCY OF THE HOME FOOD ENVIRONMENT FOR WOMEN EXPERIENCING FOOD INSECURITY

Introduction

Food insecurity, which encompasses the limited or uncertain availability of adequate foods, is associated with poor overall diet quality for low-income adults and particularly women (Leung et al., 2014). Inherent in the conceptualization of food insecurity is an understanding of the negative impact on dietary patterns and consistent access to food. Food insecurity typically manifests as a dynamic experience, dependent on the financial resources available to purchase adequate food. Additionally, the USDA has found that individuals living in very low food secure households may experience recurrent but not necessarily constant disruptions in their food availability and dietary intake throughout a year (Coleman-Jensen et al., 2019; Seligman & Schillinger, 2010). Research on the inconsistency in food availability among low-income and food insecure adults has identified monthly variations in food availability and dietary intake known as the "feast and famine cycle" (Dinour et al., 2007; Hamrick & Andrews, 2016; Tarasuk et al., 2007; Todd, 2015; Wilde & Ranney, 2000). In this cycle, individuals experience a "feast" period, which coincides with the receipt of assistance benefits and other income,

where food availability is greatest in the household. Later in the month as benefits and financial resources decline, the 'famine' period arises where eating patterns are disrupted, variety is reduced, and access to food becomes inconsistent. Thus, the availability and consistency of food in the home becomes a key area of interest for examining the impacts of food insecurity on diet quality of low-income adults.

Although instances of food consumption away from home are increasing in the U.S., the majority of daily intake still occurs within the home (Saksena et al., 2018). Especially for adults of low socioeconomic status who obtain food away from home less frequently than those of higher socioeconomic groups (Saksena et al., 2018). The home food environment includes the availability of foods and beverages within the home, acts as an intermediary between the greater food environment and individual level food intake and exerts a strong influence over food choice (French et al., 2008; Story et al., 2008). Consequently, when the home food environment reflects a wide variety and availability of healthy food options, this may be reflected in greater overall diet quality among individuals in the environment. A study examining the home food environment of low-income overweight and obese women found that greater numbers of fruits and vegetables in the home was predictive of increased intake of fruits and vegetables (β= 0.11; SE= 0.02; $P < .001$) (Kegler et al., 2014). However, in this same study, the higher prevalence of high-fat food items in the home was also positively associated with fat intake among participants (β= 0.45; SE= 0.15; $P < .001$) (Kegler et al., 2014). For individuals living in food insecure households, the home food environment is often associated with low availability and variety of fruits and vegetables other nutrient-dense foods in the home

(Gregory et al., 2019; Kegler et al., 2014; Nackers & Appelhans, 2013; Sharkey et al., 2010; Sisk et al., 2010). Yet, few studies have evaluated the home food environment of food insecure women at multiple time points within a month. The work of *Sharkey et al.* and *Sisk et al.* demonstrates the importance of using multiple home food inventory assessments to investigate changes in the home food environment of food insecure households in a month (Sharkey et al., 2010; Sisk et al., 2010). Thus, the objective of the present feasibility study was to examine associations between food insecurity and monthly changes in variety of food available at the household level for low-income women. We hypothesized that there would be a decline in the overall variety in the home food environment from the beginning to the end of the month periods, particularly for fresh fruits and vegetables.

Methods

Study Design

This cross-sectional feasibility research study was conducted in Greensboro, NC during the period of 2018-2019. This study utilized primarily quantitative measures and some qualitative methods to understand participants perceptions of the home food environment in a typical month. This study was approved by the UNC Greensboro Institutional Review Board (IRB 17-0426). Participants in this study were adult, non-pregnant or breastfeeding, English-speaking women with low incomes based on the 2018-2019 U.S. Department of Health and Human Services Federal Poverty Guidelines. All participants provided written consent to participate in two telephone interviews. As

compensation for their time and participation in this study, participants received Wal-Mart gift cards for each interview.

Recruitment Methods

Participants were recruited using convenience sampling from various community organizations and social agencies in the Greensboro metropolitan area which serve low-income women and families such as the Women's Resource Center and Guilford County Child Development. Women were contacted and recruited for this study using several different approaches: direct in-person recruitment, indirect recruitment with flyers, and participant referrals or "snow-ball recruitment". In-person recruitment took place at Expanded Food and Nutrition Education Program classes hosted by a local child development center and public housing authority. Participants who completed the study were asked to refer any potentially eligible friend or family member they thought may also be interested in the study for an additional cash incentive of $15. All contacts who indicated interest in the study were pre-screened for study eligibility criteria.

Data Collection

Each participant was asked to complete two telephone interviews within a one-month period, where one interview was scheduled in the 'beginning of the month' and the other in 'end of the month'. The interviews were scheduled individually with each participant according to the timing of receiving major household income, food assistance, and other benefits for the participant or her family in a typical month. The 'beginning of the month' period was designated as 7 to 8 days from the day the participant received the majority of her household income and/or assistance benefits (i.e. SNAP, disability, etc.),

and one of the interviews was scheduled during this time period. The 'end of the month' was designated as approximately 2-3 weeks from the 7-8 days of the beginning of the month period and the second interview was scheduled during this time.

All interviews were completed via telephone and covered 5 major sections: 1) socio-demographics, 2) food security status, 3) food shopping patterns and attitudes, 4) eating behaviors, 5) and the home food environment. For this study, specifically, the home food environment section was used to meet the objectives.

The home food environment survey was developed for this study using previously validated home food environment assessment tools (Bryant et al., 2008; Fulkerson et al., 2008; Miller & Edwards, 2002). These assessment tools specifically focus on the availability (presence or absence) of "healthy" and/or "unhealthy" foods or specific food groups such as fruits and vegetables in the home. The tool used in this study was developed to capture the overall variety of all different types of foods in the home during two periods in a month.

The study interviewer conducted the home food environment assessment over the phone while participants were in their homes. Participants were asked to physically move through their kitchens and homes looking in any place where food may be stored, including in refrigerators and freezers. To reduce participant burden, the survey was organized by location of food (e.g. refrigerator, or pantry) and then by food group. In total, the survey included 140 food items, and participants were asked to report any additional food item that was not included in the survey. The survey was completed using a 3-step pass method where in pass one the interviewer read a list of food items out to the

participant by food group section (i.e. “fresh fruits”, or “fresh vegetables”) and participants responded with ‘yes’ or ‘no’ for having the food in the home. In pass two, once each sub-section was complete the interviewer read the list of responses back to the participant to confirm no missing or incorrect food items. Finally, when each sub-section was completed, in pass three the interviewer reviewed the entirety of the survey with the participant and prompted for missing items or additional foods that may not have been included in the original survey items (see Appendix D and E). Participants indicated whether the overall amount of food currently in the home was ‘more than usual’, ‘about the same’, or ‘less than usual’. Scores for frequencies of different types of foods were calculated for each major food category, i.e. fresh fruits, fresh vegetables, meats, dairy products, etc. to measure variety of foods available.

For food shopping patterns and attitudes participants were asked a series of yes or no questions related to their typical monthly shopping patterns and feelings about household food within a month. Frequencies for these responses were calculated for each question. In the qualitative assessment, participants were asked to expand upon each answer to explain their response in an open-ended format. Selected qualitative responses are highlighted in the results section to be representative of common responses.

The United States Department of Agriculture’s Household Food Security Scale was used to measure food security status of participants, with a reference period of one year previous (ERS, 2012). Food security status is determined based on the number of affirmative responses given by participants. The number of affirmative responses is summed for a total score which corresponds to one of the levels of food security: high

food security, marginal food security, low food security, and very low food security. Participants with high or marginal food security are considered to be food secure. Those with low or very low food security are considered to be food insecure.

Data Analysis

Descriptive statistics and frequencies were calculated to analyze sociodemographic characteristics, food security status, perceptions of home food availability and food purchasing, and the home food environment survey. All statistics were analyzed using IBM SPSS 26. The nonparametric Mann-Whitney U test, Wilcoxon signed-rank test, and Friedman's test were used due to the small sample size of this study.

Results

In total, 13 women completed the first interview of this study, and 10 women participated in the second follow-up interview. The 3 women who did not complete a follow-up interview were unable to be contacted to discover their reason for discontinuing the study. All beginning of the month interviews were completed within 1-8 days of the participants' receipt of major income or assistance benefits, and all end of the month interviews were completed within 19-30 days of the date of major income. Participants reported income at one time period in this study and did not report any other potential receipt of income throughout the study month.

The sociodemographic characteristics of the study participants are presented in Table 1. The average age of participants was 46.5 years, and most identified as African American (76.9%) and single for marital status (76.9%). The prevalence of food insecurity was relatively high with 69% of participants reporting experiencing low to

very low food security. Women in this study reported utilizing various types of federal or state assistance programs such as the Supplemental Nutrition Assistance Program (SNAP) (53.8%), Medicaid (69.3%), Social Security Disability (38.5%), and Housing Choice Voucher Program Section 8 (30.8%) to meet their needs. The average monthly food budget was $341.00 (SD= $100.82) while the average monthly SNAP benefit was $247.67 (SD= $102.52). Additionally, to supplement their monthly food supply, participants reported regularly using both food pantries (62%) and soup kitchens (39%) for assistance.

Table 1

Sample Characteristics of Women Participating in a Home Food Environment Study (n=13)

	Mean (95% CI)
Age (y)	46.5 (40.1, 52.8)
Monthly Income	$1445.23 (1171.63, 1718.83)
Travel Time to Store (min.)	18.6 (3.3, 21.1)
Monthly Food Budget	$341.00 (247.76, 434.24)
Amount of SNAP[a] Benefit	$225.14 (130.33, 319.96)
	n (%)
Race/Ethnicity	
African American	10 (76.9)
Non-Hispanic White	3 (23.1)
Employment Status	
Employed	8 (61.5)
Receiving Disability Benefits	5 (38.5)
Marital Status	
Single	10 (76.9)
Married	3 (23.1)

Food Security Status	
Food Secure	4 (30.1)
Food Insecure	9 (69.2)
Level of Education	
≤12 years	5 (38.5)
≥12 years	7 (53.8)
Household Size	
1	3 (23.1)
2	5 (38.5)
3-4	5 (38.5)
Participating in…	
Medicaid	9 (69.3)
SNAP[a]	7 (53.8)
Section 8 Housing Assistance	4 (30.8)
Use Food Pantries	8 (61.5)
Use Soup Kitchens	5 (38.5)

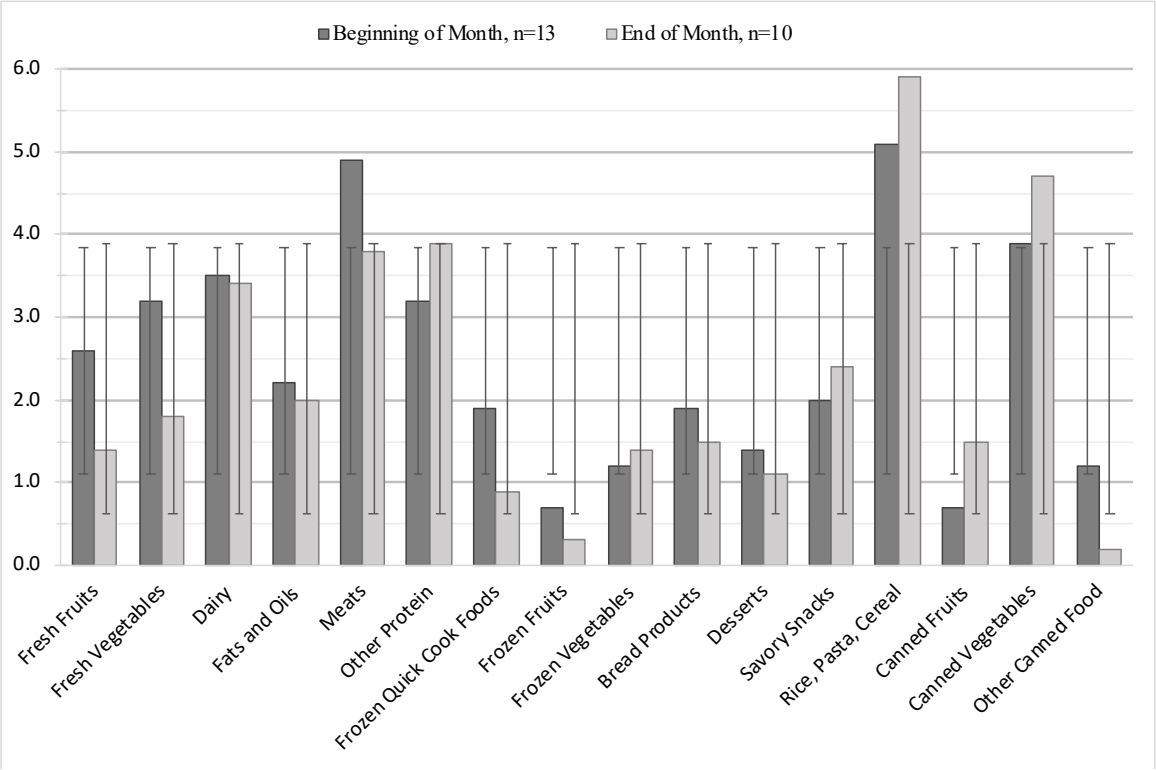
[a] Supplemental Nutrition Assistance Program

From the first interview in the beginning of the month to the second interview in the end of the month, the overall mean variety of fresh fruits and vegetables, meats, frozen quick cook foods and fruits, bread products, desserts, and other canned foods decreased (Figure 1). However, there was an overall increase in mean variety of canned fruits and canned vegetables from the beginning to the end of the month. In the beginning of the month, 43.8% of households had three or more varieties of fresh fruit in the home, whereas in the end of the month only one household had this same variety of fresh fruit (Table 2). Frozen fruit was even less common in participants' homes during the month, with 53.8% and 70.0% reporting no frozen fruit at interviews one and two respectively. Similarly, the variety of different canned fruits was low in participants' households and at the beginning of the month 61.5% had no canned fruit and 30.8% had only one or two varieties. In the beginning of the month, the most frequently reported fresh fruits in the

home were apples (46.2%), grapes (30.8%), and avocados (23.1%), bananas (23.1%), and oranges (23.1%). In the end of the month survey, participants reported having apples (40%), strawberries (20%), and lemons or limes (20%) available at home.

Figure 1

Variety of Foods in the Home Food Environment from Beginning to End of Month, Mean (SD)



From the beginning to the end of the month the mean variety of fresh vegetables decreased from 3.2 to 1.8 different types (Figure 1). For fresh vegetables, in the beginning of the month 38.5% of women had none in the home, and 61.5% had at least three different varieties. The most common fresh vegetables in the home in the beginning

of the month were bell peppers (38.5%), onions (38.5%), potatoes (30.8%), spinach (30.8%), tomatoes (30.8%), carrots (23.1%), corn (23.1%), and lettuce (23.1%). In the end of the month, 30% of participants had one to two varieties of fresh vegetables, and 30% had three or more varieties. The most common fresh vegetables reported in the end of the month were lettuce (30%), bell peppers (20%), celery (20%), potatoes (20%), tomatoes (20%), and onions (20%). Compared to frozen fruits, frozen vegetables were slightly more common among participants with 46.2% at interview one and 60% at interview two reporting having at least one type of frozen vegetable in the home. Participants reported much greater variety for canned vegetables and 23.1% had between one and two varieties and 61.5% had more than three varieties of canned vegetables available in the beginning of the month. The variety of canned vegetables remained relatively stable at the end of the month where 20% reported between one and two varieties and 70% reported three or more varieties of canned vegetables then. The most popular canned vegetables at both interviews were corn, peas, and green beans (results not shown). When total fresh, frozen, and canned fruits and vegetables were combined, participants' median variety of total fruits decreased from 4.0 to 3.0 during the month (Table 2). The combined variety of fresh, frozen, and canned vegetables among participants changed only slightly from a median of 8.0 to 7.5 varieties in the month under study.

Table 2

Number and Percentage of Participants with Fresh, Frozen, and Canned Fruits and Vegetables Present in the Home Food Environment

	Beginning of Month (n=13), n (%)	End of Month (n=10), n (%)
Fresh Fruit - variety		
0	2 (15.4)	2 (20.0)
1-2	4 (30.8)	7 (70.0)
≥3	7 (43.8)	1 (10.0)
Fresh Vegetables - variety		
0	5 (38.5)	4 (40.0)
1-2	0	3 (30.0)
≥3	8 (61.5)	3 (30.0)
Frozen Fruit - variety		
0	7 (53.8)	7 (70.0)
1-2	5 (38.5)	3 (30.0)
≥3	1 (7.7)	0
Frozen Vegetables - variety		
0	7 (53.8)	4 (40.0)
1-2	4 (30.8)	3 (30.0)
≥3	2 (15.4)	3 (30.0)
Canned Fruit - variety		
0	8 (61.5)	4 (40.0)
1-2	4 (30.8)	4 (40.0)
≥3	1 (7.7)	2 (20.0)
Canned Vegetables - variety		
0	2 (15.4)	1 (10.0)
1-2	3 (23.1)	2 (20.0)
≥3	8 (61.5)	7 (70.0)
	Median (Min, Max)	**Median (Min, Max)**
Total Fruits[a]	4.0 (0, 8)	3.0 (0, 6)
Total Vegetables[b]	8.0 (0, 16)	7.5 (4, 12)

[a]Total number of different types of fresh, frozen, and canned fruits.

[b]Total number of different types of fresh, frozen, and canned vegetables.

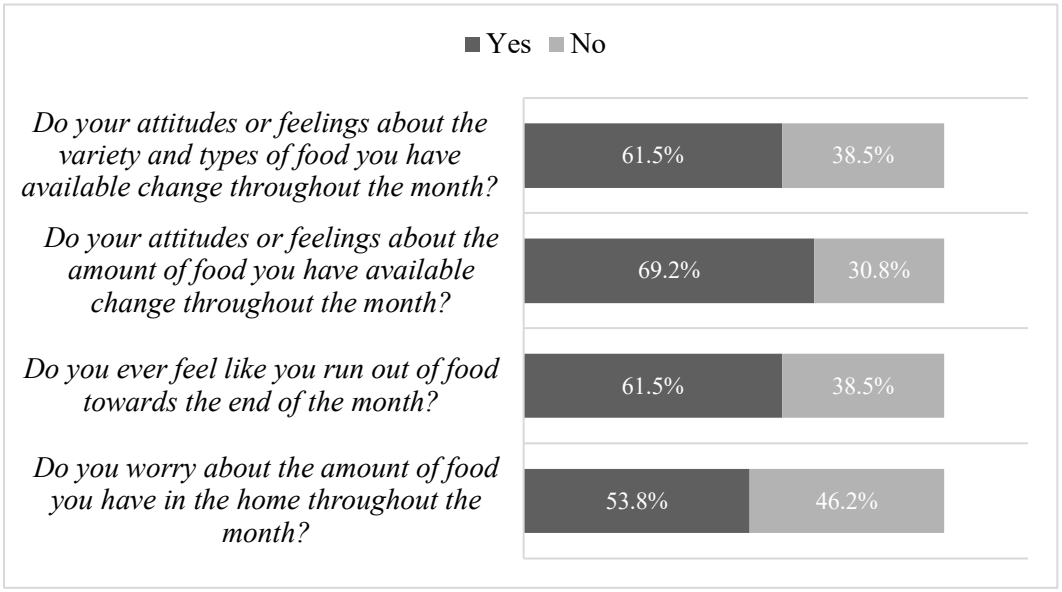
The overall availability and variety of meats decreased from a mean of 4.9 varieties at the beginning of the month to 3.8 varieties in the end of the month (Figure 1). When participants were asked whether they change where they shop for food based on how much money they have available to spend, several explicitly referenced the price and availability of meat as a key factor in their decision making. For example, “I watch for ads and coupons for sales, specifically for meat”, “I only go to [grocery store] when I spend more money because of meat, otherwise it’s expensive”, and “I can use the bus and shop at [discount grocery store] to save money on meat, they have better discounts”. Throughout this study, participants reported having as many as nine different varieties of meats and meat products in their homes in the beginning and end of the month. In the beginning of the month, the frequently reported meats were ground beef 70-85% lean (46.2%), chicken legs (38.5%), sausage (38.5%), bacon (38.5%), and chicken breasts (30.8%). In the end of month evaluation, participants reported having hot dogs (40%), chicken legs (40%), chicken breasts (40%), and turkey sausage (30%) most commonly.

Participants’ responses to questions characterizing their typical food purchasing behaviors and attitudes within a month are shown Figure 2. When asked whether they change where they shop for food based on how much money they are able to spend, 92.3% of participants responded yes and indicated that they choose between different types of food retail outlets based on their current financial situation. From the beginning to the end of the month, 76.9% of participants reported that they shop at different types of stores at different times of the month, 69.2% reported a change in attitudes about the amount of food they have available in a month, and 61.5% reported a change in attitudes

about the variety and types of foods available within a month. Several participants described the changing amount of food available in the home as a stressor in their lives as indicated by their explanations of, “I feel anxious and stressed about food at the end of the month”, “I’m happier when there’s more [food] and not as happy when there’s not, it can be a stressor”, “about the middle of the month, I know what kinds of foods I will have to eat later on and I have more anxiety then”. Participants indicated a direct connection with the variety of food available and their financial situation in a month with responses such as, “when I have more money I have a greater variety”, “there is less variety at the end of the month”, “I still try to get good variety but it becomes more and more difficult”, and “at the middle to the end of the month I realize I have to eat less healthy at the end of the month, I can’t afford the healthier foods I want to have”.

Figure 2

Low-Income Women’s Food Shopping Attitudes and Behaviors (n=13)



Participants were somewhat split over their responses to whether they worried about the amount of food they had available at home in a month, but 61.5% indicated they do feel like they run out of food towards the end of the month. And although five participants responded "no" to worrying about food in a month, two followed with remarks indicating some diminishing food supplies, "but it seems like I have less and less, especially vegetables, the fridge stays bare", and "I don't completely run out, I always have canned foods but I do run out of meats". At the end of the month interview, 50% of participants said the overall amount of food in the home was less than usual compared to the 31% who responded the same in the beginning of the month.

Discussion

The home food environment, encompassing the availability and variety of foods within the home, is a critical determinant of dietary intake and overall diet quality. In the United States, the average adult consumes approximately 67% of daily calorie consumption from food at home (Saksena et al., 2018). The present descriptive research of the home food environment of low-income adult women within a single month demonstrates that these households are lacking in variety of foods available, particularly fresh and frozen fruits and vegetables, and that the variety may be sensitive to changes in household income. As previous research has found that the presence of fruits and vegetables in the home is associated with higher fruit and vegetable intake (Kegler et al., 2014; Larson et al., 2012), the results of this study indicate participants may be at-risk for under consuming fruits and vegetables at certain periods of the month. Here, the overall variety of all types of fruits and vegetables was low in participants' households even in

the beginning of the month period, and this variety further decreased at the end of the fiscal month. In the National Household Food Acquisition and Purchase Survey (FoodAPS), food insecure households had significantly lower total diet quality scores for food at home (HEI 2010 total = 44.2) compared to food secure households (HEI 2010 total= 49.0, $P<0.01$) (Gregory et al., 2019). The food at home diet quality scores for food insecure households were also significantly lower than the scores for food secure households in the total fruit, whole fruit, whole grains, total protein, total dairy, and seafood and plant protein components (Gregory et. al, 2019). While our study included a relatively small number of participants, it is plausible that a larger scale investigation of low-income women may reveal significant differences in the home food environment of food secure and insecure individuals.

Previous research studying the home food environment has identified numerous factors such as variations in retail food access, cooking skills, food storage equipment, and others which influence food availability and variety in low-income households (Rosenkranz & Dzewaltowski, 2008). While this feasibility study is unable to identify causal relationships between receipt of income and home food availability, it was designed to follow the individual monthly income and resource patterns of participants. By interviewing participants during their specific periods of resource availability and later depletion, we were able to identify several changes in food availability in the monthly period. Had this research disregarded participants' varying schedules of income and benefits receipt, it is unlikely we would have captured these detailed changes in the home food environment. This work contributes an increase in the understanding of low-

income women's adaptability and resourcefulness in obtaining adequate foods in times of decreased financial resources. Further, this study demonstrates the feasibility of implementing data collection periods based on participants' income availability.

The results of this study indicate that a mixed methods approach to evaluating the home food environment is advantageous for incorporating, and accounting for, participants' own perceptions of monthly food availability and variety. Participants in this study were cognizant of the relationship between decreased resources and lower quality food purchases within a month and described several coping strategies such as using credit cards to buy food, utilizing food banks, eating more canned foods, and relying on social support of friends to obtain adequate food. Similar coping strategies were highlighted in the SNAP Food Security In-Depth Interview Study (Edin et al., 2013). The USDA found that 46% of respondents in the study regularly changed the types of foods they ate towards the end of the month when resources were low. SNAP participants described relying on non-perishable food items such as canned foods and inexpensive starches like ramen noodles in order to prevent going hungry at the end of the month (Edin et al., 2013). In tandem with formal home food environment assessments, open-ended questions regarding food purchasing and food availability can provide valuable context for interpreting food availability and variety data. Further research investigating the feast and famine cycle should include measures of diet quality and the home food environment throughout multiple monthly periods. Interventions aiming to improve the nutrition of low-income women should promote practical coping strategies to increase variety in home food environment and support adequate diet quality of participants.

Strengths of this study include the use of two measures of the home food environment within a single month, with the aim of capturing variations in food availability in accordance with the "feast and famine" cycle seen in low-income households. However, the home food environment survey used here was designed specifically to capture the variety of foods available and did not effectively measure amount of food in the home. This is a critical distinction as variety cannot be assumed to represent a greater overall amount of a certain food, and more research is needed to determine the most appropriate and accurate methods for measuring amount of food available. Further, participants were not asked about the number and frequency of food shopping occasions during the month under study. Participants also were not asked to report any additional income they may have received throughout the month, income was only recorded at one time point. As this was a feasibility study with a small and regional sample, results of this work are not generalizable to low-income women at large. This study relied on telephone interviews for data collection and thus results may be influenced by reporting or social desirability biases.

Conclusions

The home food environment of low-income women is subject to potentially significant changes in the availability and variety of foods within a month. In particular, the availability and variety of fresh fruits and vegetables and meats are highly vulnerable groups, with high likelihood of reduced availability in the end of the month period. It is unknown whether these changes are associated with food security status or monthly income and benefits cycles, although some work has found significant associations with

both. The complexity of the home food environment must be carefully studied in low-income households with particular emphasis placed on multiple accurate measures of food amounts, and contemporaneous assessments of dietary intake.

CHAPTER IV

ASSESSING CHANGES IN DIET QUALITY OF WOMEN EXPERIENCING FOOD INSECURITY WITHIN THE FEAST AND FAMINE CYCLE

Introduction

Food insecurity, a critical public health problem, occurs when the availability of nutritionally adequate or safe foods or one's ability to acquire such foods in socially acceptable ways is either limited or uncertain (Anderson et al., 1990). In the United States in 2018, 11.1% of households were food insecure at one point during the year, and low-income and racial/ethnic minority women were highlighted as a particularly vulnerable group disproportionately experiencing food insecurity (Coleman-Jensen et al., 2019). Being that food insecurity directly influences food intake, it is typically associated with decreased diet quality, low intake of fruits and vegetables, inadequate micronutrient intake, and an increased intake of energy-dense and nutrient-poor foods (Cowan et al., 2020; Hanson & Connor, 2014; Leung et al., 2014; Leung & Tester, 2018; Taylor et al., 2017). What is more, food insecurity has also been associated with dysregulated eating behaviors and meal patterns such as restriction and skipping meals, and uncontrolled eating or binge eating (Becker et al., 2017; Laraia et al., 2015; Rasmusson et al., 2019). With severe food insecurity, observations of hunger and reduced eating occasions are to be expected. However, research linking food insecurity to uncontrolled eating and binge

eating has identified a possible relationship with the 'feast and famine' cycle of fluctuating dietary intake in food insecurity (Becker et al., 2017).

The 'feast and famine' cycle seen in low-income and food insecure individuals describes the cyclical patterns of food availability and forced restriction due to constraints on financial resources (Althoff et al., 2016; Calloway et al., 2015; Dinour et al., 2007; Sanjeevi & Freeland-Graves, 2019; Tarasuk et al., 2007; Wilde & Ranney, 2000). The cycle begins in the 'feast' period, when household resources are high, Supplemental Nutrition Assistance Program (SNAP) benefits or household income are first received. During this period, dietary intake is observed to be more adequate or of greater quality. While, in the end of the month, when household financial resources are expended, the 'famine' period occurs and is associated with decreased diet quality, increased likelihood of skipping meals, and external restriction (Hamrick & Andrews, 2016; Wilde & Ranney, 2000). Towards the end of the month, individuals make concessions on food choice in order to maintain adequate energy intake and thus experience reduced diet quality. The cycle then continues in the following month, where the previous forced restriction in the 'famine' period leads to overconsumption or 'feasting' in the beginning of the month (Althoff et al., 2016; Brown et al., 2019). In one study where diet quality of low-income women was measured over a month, women with moderate or severe food insecurity were most susceptible to changes in dietary intake at the end of the month, specifically for decreased energy, carbohydrate, vitamin B_6, and fruit and vegetable intake (Tarasuk et al., 2007). Additionally, a study of the diet quality of food purchases in SNAP recipient households in the Food Acquisition and Purchasing Survey (Food APS) found that those

in the final 10 days of the SNAP cycle had significantly lower overall diet quality than households in the beginning of the cycle (Whiteman et al., 2018). Lastly, an analysis of the 2006-2008 American Time Use Survey found that compared to nonparticipants, SNAP participants were more likely to experience a day of no eating occasions within the month after benefits receipt (Hamrick & Andrews, 2016).

Integral to the experience of food insecurity is an association with elevated anxiety and stress around obtaining adequate food and maintaining consistency in food availability (Laraia et al., 2015; Laraia et al., 2006; Martin et al., 2016). Additionally, chronic stress is associated with unhealthy eating behaviors and increased consumption of highly palatable, energy-dense foods, particularly among women (Richardson et al., 2015; Tomiyama et al., 2011; Zellner et al., 2006). However, the relationships between women's chronic perceived stress and diet quality in food insecurity are understudied. Particularly in the context of the food insecurity 'feast and famine' cycle, where variations in dietary intake may be influenced by perceived stress and result in disrupted eating patterns. Thus, the objectives of the present study were to: 1) assess the feasibility of measuring diet quality according to low-income women's monthly income cycles, 2) determine intra-monthly changes in nutrient intake and diet quality, and 3) investigate the relationship between perceived stress and diet quality among low-income women. For objective two, we hypothesized that there would be a decrease in overall diet quality scores from the beginning to the end of the month, and declining nutrient intake. For the third objective, we hypothesized that perceived stress would be inversely associated with diet quality.

Methods

Study Design

This cross-sectional feasibility research study was conducted with 13 low-income adult women living in Greensboro, NC during the period of 2018-2019. The target population for this study was adult women experiencing food insecurity who were also not pregnant or breastfeeding, and primarily English-speaking. As such, women were excluded from participating in this study if they did not meet those criteria. The study was approved by the UNC Greensboro Institutional Review Board (IRB 17-0426) and all participants provided written consent to complete two telephone interviews. Participants received a Wal-Mart gift card (total= $150) after completing each interview as compensation for their time and efforts.

Recruitment Methods

Participants for this study were contacted and recruited in a variety of ways. First, flyers advertising this study were posted at local community and social aid organizations which serve primarily low-income adults and families. Second, in some cases the organizations allowed research staff to attend group nutrition education classes and speak about the study to potentially eligible participants. Lastly, participants who successfully completed the study were offered additional cash incentives ($15) for their personal referral of friends or family members who may be eligible and interested in also participating in the study. Regardless of contact method, all potentially eligible participants were screened for study inclusion criteria before enrollment.

Data Collection Methods

Participants were interviewed twice in a one-month period for this study. Interviews were scheduled according to participants' typical monthly receipt dates for major household income and any other assistance benefits such as the Supplemental Nutrition Assistance Program (SNAP) allotments. Thus, interview one was completed during the 'beginning of the month' period when participants reported their household financial resources were highest. Approximately 2-3 weeks following this period, interview two was completed during the 'end of the month' when participants' household resources were lowest. For participants' convenience, all interviews were completed via telephone. The interviews covered the following 4 topics: 1) socio-demographics, 2) USDA 18-item Household Food Security Survey, 3) 10-item Perceived Stress Scale (Cohen & Williamson, 1988), and 4) 24-hour dietary recall. The beginning of the month interview included all topics, whereas the end of the month interview included only the 24-hour dietary recall.

Food security status was measured using the USDA's Household Food Security Scale (ERS, 2012). Participants were asked to consider their experiences within the previous year. Scores are calculated based on the number of affirmative responses given and whether children are present in the household. For households with no children, score 0 indicates high food security, scores 1-2 indicates marginal food security, scores 3-5 indicates low food security, and scores 6-10 indicates very low food security. For households with at least one child present, score 0 indicates high food security, scores 1-2 indicate marginal food security, scores 3-7 indicate low food security, and scores 8-18

indicates very low food security. Those with high or marginal food security are considered food secure and those with low and very low food security are considered food insecure.

The 10-item Perceived Stress Scale is a validated measure used to "assess the degree to which situations in life are perceived as stressful" (Cohen & Janicki-Deverts, 2012). The scale evaluates stress within the last month, and participants respond to items using a 5-point scale with response options of "0- never", "1- almost never", "2- sometimes", "3- fairly often", or "4- very often". In the scale, six items are worded in more negative language, and four items are phrased with positive language. For example, "In the last month, how often have you felt nervous and stressed" is a negatively stated item in the scale. An example of a positively framed item is, "In the last month, how often have you felt that things were going your way". The four positive items are reverse scored, so that response options are coded as "4- never", "3- almost never", "2- sometimes", "1- fairly often", or "0- very often". The responses to all 10 items are then summed together to create a total score. In two nationally representative surveys in the U.S. in 2006 and 2009 the internal reliability of the scale was $\alpha = 0.91$ for both surveys (Cohen & Janicki-Deverts, 2012). Possible scores range from 0-40, with higher total scores on the scale signify greater psychological distress. The PSS is not a diagnostic tool and does not have predefined cut-points for different levels of stress, and interpretation of scores varies. In this study, perceived stress scores were analyzed continuously and as a binary variable based scores along the median split (DeCoster et al., 2011).

The 24-hour dietary recall was conducted using the 2017 Nutrition Data Systems for Research software (NDSR) (Nutrition Coordinating Center, University of Minnesota) following the USDA's multiple pass method. During the recall, participants were asked to report all foods and beverages consumed within the period of midnight to midnight on the previous day. Participants received a food amounts booklet containing images of foods, shapes, and measuring tools to use in their estimation of specific portion sizes and amounts consumed. During the recall, participants were encouraged to use the portion booklet. For each participant, the 24-h recall data from each occasion was used then to calculate Healthy Eating Index-2015.

Healthy Eating Index-2015

The Healthy Eating Index (HEI) 2015 is a validated measure of diet quality in comparison to the nutrient and food group intake recommendations made in the 2015 Dietary Guidelines for Americans (DGA) (Krebs-Smith et al., 2018; Reedy et al., 2018). The HEI-2015 allows for calculation of a total diet quality score, ranging from 0-100, based on the summation of 13 component scores. Component scores are calculated based on nutrient density, or amount per 1,000 kcal, based on the individual intakes of certain nutrients and food groups. The 9 adequacy components are derived from the DGA recommendations encouraging increased intake in certain food groups, such as fruits and vegetables. The 4 moderation components are derived from the DGA recommendations which encourage moderation or decreased intake in certain food groups or nutrients such as added sugars. While higher adequacy component scores reflect greater intake of corresponding foods and nutrients within those components, moderation components are

reverse-scored. Meaning, higher moderation component scores reflect decreased intake in those areas. Thus, all components are scored such that higher scores indicate more favorable or optimal intake, and a higher total score indicates greater overall diet quality. The University of Minnesota Nutrition Coordinating Center guide for calculating HEI-2015 scores from dietary recall data was used to calculate total HEI-2015 and component scores from SAS code (Nutrition Coordinating Center, University of Minnesota, n.d.). To contextualize HEI-2015 scores, *Krebs-Smith et al.* (2018) suggest readers turn to a graded approach, components are assigned a grade of A (90-100%), B (80-89%), C (70-79%), D (60-69%), or F (0-59%) based on the percentage of the maximum score met.

Data Analysis

Frequencies and descriptive statistics were calculated for socio-demographic variables, food security status, and perceived stress. Spearman's rank order correlations were calculated for nutrients and diet quality scores, perceived stress, and eating behavior variables. The Mann Whitney *U* test was used to assess differences in the distribution of nutrient and diet quality variables across food security status and other binary variables such as perceived stress. The total and average nutrient intake values for both days of intake were determined from the NDSR data files. Nutrient and food-group intake data were used to calculated HEI-2015 scores in SAS software version 9.4. All other analyses were completed in IBM SPSS 26.

Results

In total, 13 women participated in this study at interview one, and 11 women completed the second interview. Among those that discontinued the study before the

second interview, one person completed a partial interview giving only a second 24-hour dietary recall. We were unable to determine the specific reasons for these participants' discontinuance of the study. All interviews were completed within the pre-defined beginning and end of the month period for each participant. The time between receipt of major income and interview one ranged from 1-8 days, and the time between receipt of major income and interview two ranged from 19-30 days.

The socio-demographic characteristics of study participants are presented in Table 3. The participants in this study were primarily African American women (76.9%), single (76.9%), and the average age was approximately 46.5 years. The mean monthly income for participants was $1445.23 the median household size was 2 people. For food security status, 69.2% of participants were experiencing food insecurity, or low to very low food security. About half of all participants were receiving SNAP benefits, and their mean monthly benefit was $225.14 (95% CI: 130.33, 319.96). Additionally, participants also reported using both food pantries (61.5%) and soup kitchens (38.5%) for food assistance on a regular basis.

Table 3

Demographic Characteristics of Study Participants (n=13)

	Mean (95% CI)
Age (y)	46.5 (40.1, 52.8)
Monthly Income	$1445.23 (1171.63, 1718.83)
Monthly Food Budget	$341.00 (247.76, 434.24)
Amount of SNAP[a] Benefit	$225.14 (130.33, 319.96)

	n (%)
Race/Ethnicity	
African American	10 (76.9)
Non-Hispanic White	3 (23.1)
Employment Status	
Employed	8 (61.5)
Receiving Disability Benefits and Unemployed	5 (38.5)
Marital Status	
Single	10 (76.9)
Married	3 (23.1)
Food Security Status	
Food Secure	4 (30.1)
Food Insecure[b]	9 (69.2)
Level of Education	
≤12 years	5 (38.5)
≥12 years	7 (53.8)
Household Size	
1	3 (23.1)
2	5 (38.5)
3-4	5 (38.5)
Participating in…	
Medicaid	9 (69.3)
SNAP[a]	7 (53.8)
Section 8 Housing Assistance	4 (30.8)
Use Food Pantries	8 (61.5)
Use Soup Kitchens	5 (38.5)
Perceived Stress Scale	
Low stress, scores 0-19	7 (53.8)
High stress, scores >19	6 (46.2)

[a] Supplemental Nutrition Assistance Program
[b] Includes low to very low food security status

The results of nutrient analyses for the beginning and end of month recalls are presented in Table 4. In terms of mean energy intake, it remained relatively stable between the beginning ($\bar{x}$=2059.2 kcal, 95% CI: 1734.8, 2383.6) and end of month

periods ($\bar{x}$=2068.5 kcal, 95% CI: 1650.2, 2486.8). For macronutrients, mean protein intake was also stable at approximately 15-16% of total energy intake during the month. In terms of percentage of energy from fat, mean intake decreased from 40.9% in the beginning to 35.8% in the end of the month. From the beginning to the end of the month, the mean percentage of total energy intake contributed by both carbohydrates (42.1% vs. 48.2%) and added sugars (11.3% vs. 14.1%) increased. The average consumption of dietary fiber increased from 16.5 g in the beginning of the month to 19.2 g in the end of the month.

Table 4

Comparison of Nutrient Intakes from Beginning (n=13) to End of the Month (n=11)

	Beginning of the Month		***End of the Month***	
	Mean (95% CI)	**Median (Min, Max)**	**Mean (95% CI)**	**Median (Min, Max)**
Total Energy, *kcal*	2059.2 (1734.8, 2383.6)	2010.5 (1236.4, 2863.4)	2068.5 (1650.2, 2486.8)	1766.8 (1465.5, 3444.5)
Percentage of Total Energy From:				
Carbohydrates, %	42.1 (35.6, 48.6)	39.8 (28.1, 58.5)	48.2 (40.2, 56.1)	48.1 (31.1, 69.1)
Protein, %	15.2 (12.7, 17.7)	16.1 (7.2, 20.1)	15.9 (11.0, 20.9)	15.5 (9.0, 35.0)
Fat, %	40.9 (34.7, 47.1)	41.9 (23.1, 53.4)	35.8 (29.3, 42.3)	37.2 (19.9, 50.3)
Saturated Fat, %	12.8 (9.6, 16.0)	12.5 (4.6, 22.9)	9.9 (7.4, 12.3)	11.3 (3.6, 14.0)
Added Sugars, %	11.3 (6.7, 15.8)	10.1 (1.9, 30.9)	14.1 (10.3, 17.8)	15.9 (5.5, 20.2)
Carbohydrate, *kcal*	867.3 (686.6, 1047.9)	764.9 (495.8, 1423.3)	978.9 (839.0, 1118.7)	941.9 (684.5, 1354.8)
Protein, *kcal*	322.3 (244.5, 400.2)	308.3 (89.1, 561.2)	343.3 (208.1, 478.6)	240.3 (165.7, 720.1)

Fat, *kcal*	822.4 (671.3, 973.6)	887.1 (460.6, 1263.2)	787.3 (500.1, 1074.5)	743.6 (295.7, 1808.7)
Saturated fat, *kcal*	259.4 (201.2, 317.5)	241.0 (104.1, 465.2)	212.3 (136.3, 288.3)	196.0 (63.3, 465.7)
Added Sugars, *g*	56.0 (36.2, 75.9)	58.4 (8.3, 106.2)	70.8 (49.4, 92.2)	70.5 (27.0, 134.3)
Total Dietary Fiber, *g*	16.5 (9.7, 23.2)	12.8 (6.4, 35.5)	19.2 (11.0, 27.3)	12.5 (9.8, 46.7)

Overall diet quality was poor among participants with a mean total HEI-2015 score of 45.2 in the beginning of the month and 50.8 in the end of the month (Table 5, Figure 3). In the beginning of the month, the lowest mean percent adequacy scores were observed in the total fruits (22.6%), whole grains (27.6%), whole fruits (30.0%), and beans and greens (34.6%) components. Among the moderation components in the beginning of the month mean percent sodium scores were the lowest (34.9%), reflecting greater sodium intake. In the beginning of the month, the component scores for total protein foods and added sugars were highest, with respective mean scores meeting 86.4% and 74.7% of the standard for maximum score.

In the end of the month, mean total protein foods score remained the highest with scores at 83.2% of the standard, and mean fatty acids scores were the second greatest meeting 78.3% of the standard. The lowest adequacy component scores in the end of the month were observed in the seafood and plant protein (38.6%), total fruits (30.6%), greens and beans (40.2%), and dairy (40.2%) categories. The lowest mean percent scores for moderation components in the end of the month were sodium (35.9%) and refined grain scores (35.8%).

Table 5

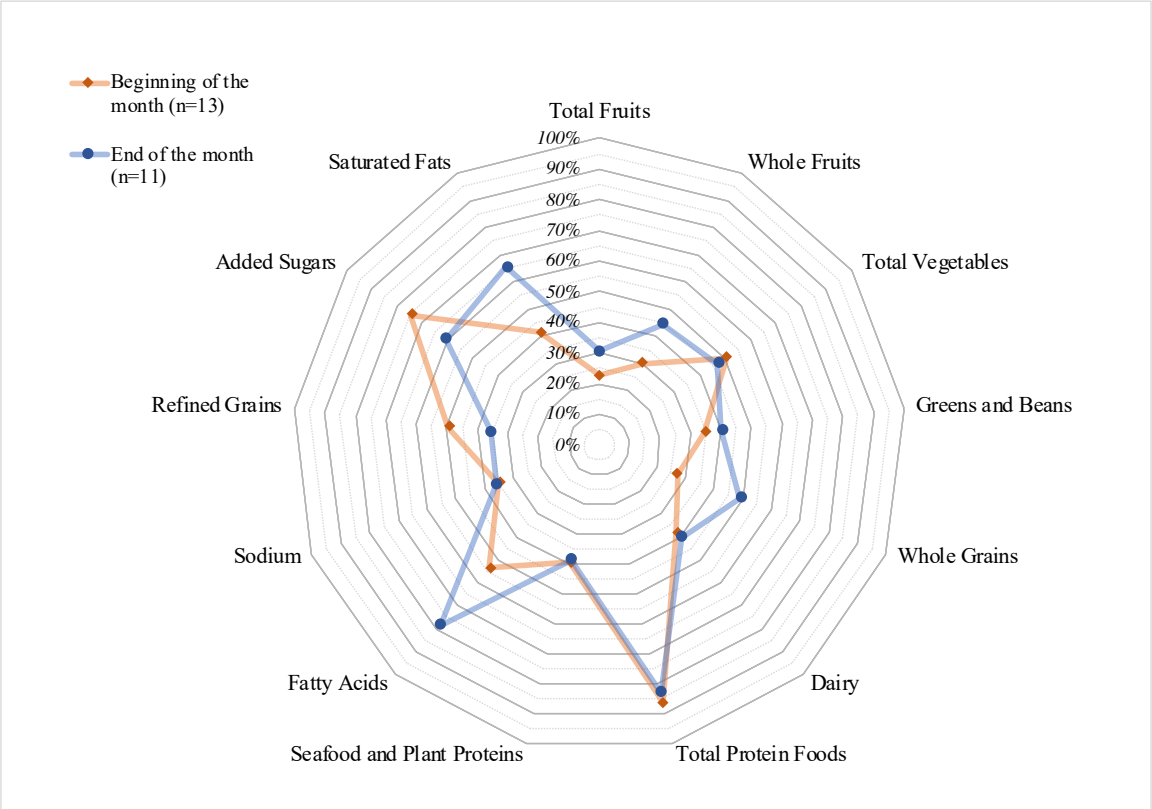
Mean Healthy Eating Index-2015 Scores in the Beginning (n=13) and End of the Month (n=11)

	Optimum Score	*Beginning of the Month*		*End of the Month*	
		Mean (95% CI)	**% score met**	**Mean (95% CI)**	**% score met**
Total HEI-2015 Score	100	45.15 (34.37, 55.94)	45.2	50.77 (41.63, 59.91)	50.8
Adequacy[a]:					
Total Fruits	5	1.13 (0.00, 2.27)	22.6	1.53 (0.56, 2.50)	30.6
Whole Fruits	5	1.50 (0.19, 2.81)	30.0	2.23 (0.93, 3.54)	44.6
Total Vegetables	5	2.51 (1.56, 3.46)	50.2	2.35 (1.43, 3.27)	47.0
Greens and Beans	5	1.73 (0.38, 3.08)	34.6	2.01 (0.50, 3.52)	40.2
Whole Grains	10	2.76 (0.08, 5.43)	27.6	4.91 (1.93, 7.90)	49.1
Dairy	10	3.81 (1.84, 5.77)	38.1	4.02 (1.27, 6.78)	40.2
Total Protein Foods	5	4.32 (3.52, 5.13)	86.4	4.16 (3.10, 5.22)	83.2
Seafood and Plant Proteins	5	1.98 (0.49, 3.47)	39.6	1.93 (0.27, 3.58)	38.6
Fatty Acids	10	5.37 (2.59, 8.16)	53.7	7.83 (5.86, 9.80)	78.3
Moderation[b]:					
Sodium	10	3.49 (0.99, 6.00)	34.9	3.59 (1.71, 5.46)	35.9
Refined Grains	10	4.94 (2.73, 7.14)	49.4	3.58 (1.44, 5.72)	35.8
Added Sugars	10	7.47 (5.63, 9.31)	74.7	6.08 (4.21, 7.96)	60.8
Saturated Fats	10	4.15 (2.05, 6.25)	41.5	6.54 (4.73, 8.36)	65.4

[a] Higher adequacy scores indicate higher consumption
[b] Higher moderation scores indicate lower consumption

Figure 3

Radar Plot of HEI-2015 (%) Component Scores in the Beginning and End of the Month

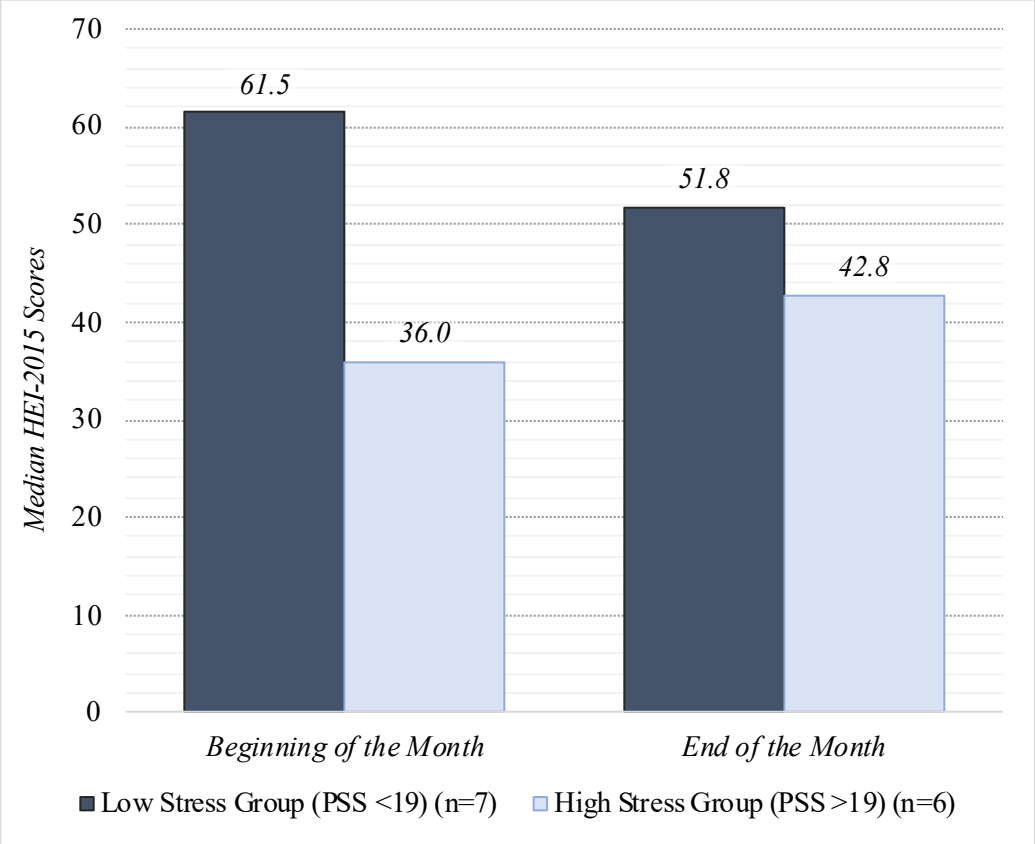


The mean perceived stress scale scores were relatively high in the sample overall ($\bar{x}$=19.9), and food insecure participants had a higher mean stress score than food secure participants ($\bar{x}$= 21.4 vs. $\bar{x}$= 16.3). In the beginning of the month, median total HEI-2015 score was greater in the low stress group compared to the high stress group, U=18.00, z=-0.43, p=0.73 (Figure 4). In HEI-2015 component analyses, perceived stress scale scores in the beginning of the month were negatively correlated with HEI-2015 scores for added sugar (r_s(13)= -0.642, p=0.02), such that increased stress was correlated with greater intake of added sugar. In the end of the month, median total HEI-2015 score was

significantly higher in the low stress group than in the high stress group, U=3.00, z=-2.19, p=0.03. In the end of the month, perceived stress scale scores were negatively correlated with HEI-2015 whole fruit scores ($r_s(11)$= -0.682, p=0.02), indicating a relationship between increased stress and decreased whole fruit intake.

Figure 4

Comparison of HEI-2015 Scores by Perceived Stress



Discussion

The results of this exploratory study indicate overall poor intake of nutrient-dense foods, and intake of certain food groups and nutrients, such as fruits and vegetables, are

vulnerable to change from the beginning to the end of the fiscal month among low-income women. Specifically, changes in carbohydrates, added sugars, sodium, dietary fiber, and intake of refined grains were observed, among others. Using the HEI-2015 grading guidelines, an F grade could be assigned to all component scores in the beginning of the month except for total protein foods and added sugars which would have grades B and C, respectively. Similarly, in the end of the month, all components would receive a grade of F with exceptions for total protein foods (B), fatty acids (C), added sugars (D), and saturated fats (D). These results are concerning, but not necessarily surprising given that low-income and food insecurity are commonly associated with poor overall diet quality and a decreased intake of fruits and vegetables (Champagne et al., 2007; Hiza et al., 2013; Leung et al., 2014; Taylor et al., 2017).

Perceived stress may be an important predictor of diet quality among low-income women. In this study, participants with lower perceived stress had improved overall diet quality compared to those with higher stress. There was also an association with higher perceived stress and consumption of added sugars. Research on the relationship between chronic stress and diet quality has demonstrated that low-income women are disproportionately affected by chronic stress compared to their low-income male counterparts and higher-income women (Moore & Cunningham, 2012; Torres & Nowson, 2007). In an investigation of this pathway, one study of women with children participating in the Special Supplemental Program for Women, Infants, and Children (WIC) found that perceived stress was positively associated with uncontrolled eating and emotional eating (Richardson et al., 2014). The women in that study also demonstrated

poor overall diet quality (mean total HEI-2010 score= 43.9, SD= 1.6) although this was non-significance in modeling analyses with perceived stress (Richardson et al., 2014). As chronic stress has been associated with increased intake of highly palatable foods, it is likely that stress is at least partially driving low-income women's choices for high-sugar and refined grain foods (Adam & Epel, 2007; E. Epel et al., 2001; Groesz et al., 2012; Torres & Nowson, 2007). And, though the relationship between stress and diet quality is multifactorial, it may also be that towards the end of the month, perceived stress potentially has a greater effect on food choices because purchasing power, food availability and variety is lower in low-income households.

This study was designed to assess participants' diet quality during two potentially distinct periods of resource availability and depletion time in the monthly income and benefits cycle. Although previous research has found evidence of decline in diet quality towards the end of the month as income and benefits run out (Sanjeevi & Freeland-Graves, 2019; Tarasuk et al., 2007; Whiteman et al., 2018), this was not the case among our participants. While we did not find a decrease in total diet quality at the end of the month, and overall energy intake remain relatively unchanged, we did observe changes in intake of refined grains, added sugars, and total dietary fiber. For example, the median percentage of total energy intake from added sugars increased from 10.1% in the beginning of the month to 15.9% in the end of the month. Similarly, in a study of 151 women participating in SNAP, diet quality declined significantly over the course of the month following benefits receipt, and there was a significant increase in refined grain intakes in the fourth week of the month (Sanjeevi & Freeland-Graves, 2019). In

interpreting these results we look to the research on coping strategies in food insecurity. Frequently reported coping strategies in food insecurity include restricting food intake, changing types of foods consumed, utilizing food pantries, and leaning on social networks for support, among others (Calloway et al., 2015; Edin et al., 2013; Hadley & Crooks, 2012). In particular, low-income women are likely to increase their intake of more low-cost and non-perishable food items and rely on these as a coping strategy which may in turn negatively affect diet quality. In the SNAP Food Security In-Depth Interview Study (n=90 households), 46% of participants reported increasing their consumption of canned goods, ramen noodles, potatoes, pasta, and other starchy foods in response to declining resources and food availability (Edin et al., 2013). Thus, it is possible that the end of month increases in intake of refined grains, added sugars and reduced dietary fiber in this study are evidence of some adaptive food choices in response to resource constraints.

This study is limited by a number of factors, primarily small sample size and limited ability for between group comparisons among participants. As this was a feasibility study with a limited number of participants, we are conservative in our inferences of the results. Dietary data is limited by the collection of only one recall during each time point, and therefore cannot be assumed to reflect usual intake. Additionally, self-reported dietary recalls are subject to errors in accuracy, completeness, and may also be affected by reporting bias. Due to the small sample size, we were not able to assess differences in diet quality by food security status during the intra-monthly monthly period although this would be important in future research. However, this work contributes to

the understanding of how low-income women's diet quality changes within a month and which nutrients and food groups are more vulnerable to change. Overall, diet quality in this sample was largely sub-optimal in comparison to the 2015 Dietary Guidelines for Americans and indicates this group is at-risk for poor nutrition status.

Conclusions

We demonstrated the feasibility of assessing low-income women's diet quality according to their individual monthly income and benefits cycles. This work contributes to the understanding of how low-income women's diets change when resources are depleted within a month. The women in this study had poor overall diet quality within a month and did not meet recommendations for intake of fruits, vegetables, whole grains, and other nutrients and food groups promoted in the 2015 DGA. Continued support of federal food assistance programs and nutrition interventions within this population is essential to improve nutrition-related health outcomes. Future research should continue to measure perceived stress and potential associations with eating behaviors and dietary intake.

CHAPTER V

FUNCTIONAL NEUROIMAGING IN FOOD INSECURITY: A CASE STUDY OF LOW-INCOME WOMEN

Introduction

In the U.S. low-income, single, and racial/ethnic minority adult women are particularly vulnerable to experiencing food insecurity (Coleman-Jensen et al., 2019). Food insecurity is characterized by disrupted eating patterns and an overreliance on low-cost energy-dense foods resulting in overall poor diet quality and weight outcomes (Cowan et al., 2020; Hanson & Connor, 2014; Leung et al., 2014; Leung & Tester, 2018; Taylor et al., 2017). One coping strategy for dealing with disrupted eating patterns is to make food choices based on greater energy density rather than nutrient density to protect overall energy intake. And, this choice is reinforced by the low financial cost of energy dense foods compared to the higher cost nutrient dense and low-energy foods (Aggarwal et al., 2011; Darmon & Drewnowski, 2015; Maillot et al., 2007). Another coping strategy in food insecurity is the "feast and famine cycle" where eating behaviors are characterized by 'feasting', or overconsumption when food is available, and 'famine' where eating behaviors are restricted due to low food availability and the likelihood for experiencing hunger increases (Althoff et al., 2016; Dinour et al., 2007). It is hypothesized that the inconsistency in food availability and subsequent adaptive eating

behaviors ultimately results in an increased physiological fat storage, insulin resistance, and weight gain (Sinha, 2017; Laraia, 2013; Rutten et al., 2010).

Some research suggests that this cycle in combination with the economic and psychosocial constraints associated with food insecurity, such as chronic stress, has a biobehavioral effect on food insecure individuals (Laraia et al., 2017). Where the experience of food insecurity has a physiological effect which then negatively influences food choices and diet quality. For instance, the chronic perceived stress experienced in food insecurity results in activation of the hypothalamic-pituitary-adrenal (HPA) axis for the release of the hormone cortisol which increases appetite and motivation to consume highly palatable foods (Epel et al., 2012; Groesz et al., 2012; Sinha, 2017; Zellner et al., 2006). Although the term highly palatable food is commonly used in research, there is no formal definition. Generally, highly palatable foods are described as energy-dense and also contain combinations of ingredients such as increased fat, sugar, and sodium, which contribute to the palatability of the food and are suggested to bypass satiety mechanisms and activate neural reward pathways (de Macedo et al., 2016; Fazzino et al., 2019; Sinha, 2017). The specific brain regions of the lateral hypothalamus, nucleus accumbens, ventral tegmental area, prefrontal cortex, striatum, and amygdala have been shown to have increased activation in response to palatable foods (de Macedo et al., 2016; Neseliler et al., 2017). Activation in this areas and related reward responses may further influence motivation to consume palatable food among individuals experiencing food insecurity (Lowe & Butryn, 2007).

Developments in functional Magnetic Resonance Imaging (fMRI) research have facilitated the study of brain regulation of homeostatic and hedonic food intake. In fMRI visual food stimuli are employed to measure responsive brain activation for highly palatable and healthy foods. This work has allowed researchers to identify an "appetitive network" of the limbic and cortical systems that interact with homeostatic and cognitive control networks to regulate eating behavior (Neseliler et al., 2017). This has also illuminated the individual differences the neurological processing of food stimuli as rewarding (Appelhans et al., 2011; Cheval et al., 2017). One study of adult women found that for those reporting high chronic stress, the images of high-calorie foods resulted in greater activation in regions of the brain involving reward, motivation, and habitual decision-making, and significant deactivation in the regions of executive control (Tryon et al., 2013). Evidence suggests that the experience of chronic stress may alter brain activation for food stimuli which predisposes an individual for overconsumption of palatable foods or "comfort foods", by increasing their reward value, and reducing the individual's ability to exercise restraint in response to palatable food cues (Adam & Epel, 2007; Epel et al., 2012; Sinha, 2017). However, little is known about how chronic stress responses may influence reward sensitivity and diet quality among women experiencing food insecurity. The overall goals of this research were to: 1) determine the feasibility of fMRI research among women experiencing food insecurity, and 2) investigate intra-monthly changes in brain activation for visual food stimuli using fMRI with women experiencing food insecurity. To achieve that end, we have presented two cases of low-

income adult women experiencing food insecurity, who are particularly vulnerable to increased stress and disrupted eating patterns.

Methods

Study Design

This study was conducted in Greensboro, NC during the period of 2018-2019 with participants recruited from community and social agencies (i.e. Greensboro Child Development, Women's Resource Center, Interactive Resource Center) via in-person recruitment and indirectly with study flyers. This study was approved by the UNC Greensboro Institutional Review Board (IRB 17-0426). All those interested in participating were pre-screened for study eligibility criteria including MRI-specific safety criteria (Appendix C). Participants in this study were English-speaking low-income, adult women who were non-pregnant or breastfeeding. All participants provided written consent to complete two interviews and two brain MRI scans. Participants were given Wal-Mart gift cards following each scan (total $150) and digital copies of MRI scans when available.

Women were excluded from participating if they did not meet the following eligibility criteria for target population and MRI safety criteria: 1) not taking medications which cause side effects that affect the ability to participate in MRI scans, i.e. dizziness, claustrophobia, etc., 2) no metal implants within the head or neck area, 3) no medical devices implanted within the head, neck, or body, 4) no surgery in the upper back, neck, or head area within the previous six weeks, 5) no tattoos on the upper back, neck, or head area within the previous six weeks, 6) no irremovable jewelry or metal body piercings in

the upper back, neck, or head area, 7) no glasses or eye wear during the scans, 8) no metal dental appliances held in by a magnet, 9) no intrauterine device that has not been cleared as MRI safe with the Trio 3.0 T scanner.

Data Collection

Each participant completed two brain MRI scans and two telephone interviews within a one-month period, with one set of scans and interviews scheduled at the 'beginning of the month' and the other set in the 'end of the month'. The interviews and scans were scheduled individually with each participant according to the timing of receiving major household income, food assistance, and other benefits for the participant or her family in a typical month. The 'beginning of the month' period was designated as 7 to 8 days from the day the participant received the majority of her household income and/or assistance benefits (i.e. Supplemental Nutrition Assistance Program (SNAP), disability, etc.) and the first scans and interview were scheduled within this period. The 'end of the month' was designated as approximately 2-3 weeks from the 7-8 days of the beginning of the month period and the second brain scan and interview were conducted during this time.

All interviews were completed via telephone and covered 6 major sections: 1) socio-demographics, 2) 10-item USDA Adult Food Security Survey, 3) 10-item Perceived Stress Scale, 4) 15-item Power of Food Scale, 5) the home food environment, and 6) a 24-hour dietary recall. The first interview in the beginning of the month covered all 6 sections whereas the second interview in the end of the month included only the home food environment and 24-hour dietary recall sections. The diet recall was

conducted using the 2017 Nutrition Data Systems for Research Software following the multiple-pass method (Nutrition Coordinating Center, University of Minnesota).

The 10-item USDA Adult Food Security Survey was used to determine food security status of participants without children in the household (ERS, 2012). The survey includes questions about the individual's experiences in obtaining food for the household using a reference period of the past 12 months. For scoring participant responses, each affirmative response receives a point, and possible scores range from 0-10 for households without children: 1) score 0= high food security, 2) score 1-2= marginal food security, 3) score 3-5= low food security, 4) score 6-10= very low food security. Those experiencing either high or marginal food security are considered to be food secure, and those experiencing low or very low food security are considered to be food insecure.

Dietary data was used to calculate Healthy Eating Index 2015 (HEI-2015) scores for diet quality (Krebs-Smith et al., 2018). The HEI-2015 is a method for scoring diet quality in comparison to the recommendations made in the 2015 Dietary Guidelines for Americans. The HEI-2015 consists of a total score, ranging from 0-100, and 13 component scores for individual food groups and nutrients. Greater total scores indicate greater compliance with the recommendations in the DGA and greater overall diet quality. In this case study, analysis of HEI-2015 scores is limited to total scores.

The validated 10-item Perceived Stress Scale was used to assess stress during the first interview (Cohen et al., 1983). The scale was designed to measure the degree to which life situations are perceived as stressful within the last month. Of the items in the scale, six are phrased using negative language and four are phrased using more positive

language. Participants respond to each item using a 5-point scale with the options of "0- never", "1- almost never", "2- sometimes", "3- fairly often", or "4- very often". The four positively stated items are reverse scored, and all responses are summed for a total score, ranging from 0-40. The PSS is not intended to be a diagnostic tool and does not have cut-points of scores although higher scores indicate greater stress. The internal reliability of the scale was found to be $\alpha = 0.91$ in two nationally representative surveys in 2006 and 2009 (Cohen & Janicki-Deverts, 2012).

The 15 item Power of Food Scale (PFS) used in this study was designed to measure people's desires and thoughts of eating food or thinking about eating food (Lowe et al., 2009). The PFS is used to assess an individual's appetite for palatable foods at three levels of proximity: 1) food available in the environment but not immediately present, 2) food physically present but not tasted, 3) food first tasted but not consumed (Cappelleri et al., 2009). Each level of proximity corresponds to a subscale such that food available contains six items, food present contains four items, and food tasted contains five items. Examples of items include, "I find myself thinking about food even when I'm not physically hungry" for food available, "If I see or smell a food I like, I get a powerful urge to have some" for food present, and "When I eat delicious food I focus a lot on how good it tastes" for food tasted. Participants respond based on their level of agreement across a 5-point scale: "1- I don't agree", "2- I agree a little", "3- I agree somewhat", "4- I agree quite a bit", "5- I strongly agree". Subscale scores are calculated as the mean score per item within the scale and range from 1-5, and a total score is calculated from the mean scores of the three subscales, also ranging from 1-5. Higher PFS scores indicate

greater preoccupation with food or increased thoughts about food even when an individual is not physically hungry.

MRI

The brain MRI scans were conducted locally at the Joint School for Nanoscience and Nanoengineering (JSNN) non-medical research facilities. Participants were offered the pre-determined windows of time for scheduling their beginning of the month and end of the month scans and could request virtually any specific day or time of day within those periods for their own convenience. Thus, scans occurred during weekdays and weekend days, and at various times during the day. All participants completed a full safety screening prior to the scanning session in accordance with facility regulations (See Appendix H). Participants self-reported their current feelings of hunger and anxiety, and general stress within the last week using Likert scales (See Appendix D). For hunger, responses ranged from 1-10 where 1 was described as 'not at all hungry', 5 was 'somewhat hungry', and 10 was 'extremely hungry'. Research staff then explained in detail the MRI scanning procedures, describing the length of time participants would be in the scanner itself, and instructions for communication with staff during the scan. The MRI appointments lasted approximately 1-1.25 hours total, including the time spent briefing the participant on scanning procedures and conducting safety screenings. During the scanning session including the structural, resting state, and functional scans the time participants spent inside the scanner was approximately 37 minutes. Throughout the scanning process, staff regularly communicated with participants inside the scanner via a

headphone and intercom system. This allowed staff to monitor participants' comfort and safety and provide cues when needed for participants to open or close their eyes.

Resting state, structural, and functional scans were conducted using a Siemens MAGNETOM Tim Trio 3.0 T Scanner. The structural scan was conducted first to obtain a high-resolution 3-D structural image of the brain. Then the resting state scan was collected. During the resting state scan participants were instructed to keep their eyes closed for the duration of the scan, to not think about anything in particular, and to avoid falling asleep. The purpose of the resting state scan was to determine participants' baseline brain activation without the presence of any stimuli. Following this, the functional task was conducted.

During the functional scan, images were displayed using a computer in the control room with Microsoft PowerPoint software connected to an MRI-safe projector within the magnet room. Images were projected onto a screen behind the MRI machine and viewed via a rear-projecting mirror attached to the head coil. Prior to starting the scans, research staff confirmed that participants could fully view the projector screen in their mirror and made adjustments to the position of the mirror as necessary.

During the fMRI scanning, visual stimuli were displayed in a block-design format. Block-design is commonly used in fMRI to display consecutive stimuli as a series of 'blocks' where stimuli from one condition are presented in one block, followed by a block of stimuli for baseline or control, followed by a block of stimuli from another condition, and so on (Soares et al., 2016). Here, the block-design consisted of 13 blocks, each containing 10 images, for a total of 130 images viewed (Table 7). During the fMRI

session one scan was obtained every 3 seconds for a total of 130 scans, or full brain volumes.

In fMRI scanning, images are commonly produced by measuring blood oxygen level dependent (BOLD) contrast response (Neseliler et al., 2017; Smith, 2004; Soares et al., 2016). BOLD contrast signals the change in the local ratios of deoxyhemoglobin to oxyhemoglobin concentration caused by increased regional neural activity (Neseliler et al., 2017). The scans obtained using fMRI are sensitive to the changes in BOLD contrast and thus parts of the scans collected during the visual stimuli show greater intensity when compared to scans collected at rest (Smith, 2004). The parts of the scans showing greater intensity then correspond to specific brain areas activated in response to the given stimuli. Thus, the strength of the BOLD contrast is considered an indirect measure of neural activity in fMRI (Neseliler et al., 2017; Soares et al., 2016).

For the fMRI task in this study, BOLD activation was measured in response to control non-food images, and in response to different conditions of food images. The images used in the fMRI were blocked by three conditions: 1) non-food control objects, 2) healthy foods, and 3) highly palatable foods (see Figure 5). All images used in the fMRI scans were sourced from the *food-pics* free database for validated MRI images for research purposes which contains 896 food images and 315 non-food images (Blechert et al., 2014, 2019). Images were selected based on 3 factors: 1) food types, 2) image characteristics, and 3) individual differences. The consideration of food types accounted for a variety of foods across different levels of food-processing (i.e. raw or whole foods, or highly processed foods), macronutrient content, and food groups such as meats, fruits,

vegetables, etc. Images themselves are balanced for certain characteristics of brightness, size, color balance, within-object contrast, and white negative space. The images were also selected to cover a wide range of individual differences in the study participants which may influence food preferences such as meat and non-meat items for vegetarians or vegans, or cultural or regional foods.

For consistency within each block, images grouped around a common theme (Table 7). For example, the block #1 of non-food objects was different pictures of leaves and blocks #7 and #9 of non-food objects were images of different animals like a dog or fish (Table 8). The highly palatable and healthy food images were also organized around a theme or similar food group. For example, blocks #2 and #10 of highly palatable food contained images of high-sugar or high-sugar and high-fat foods such as ice cream, pastries, and candy. Block #6 of highly palatable food contained images of high-fat and high-sodium foods such as pizza, french fries, and fried fish. The healthy food images in block #4 were of different vegetables like carrots, tomatoes, and mixed vegetables, whereas those in block #12 were images of fruits such as watermelon or blueberries. In block #8 of healthy food all images showed low-fat and low-sodium combination food items such as a grilled chicken salad, a grilled vegetable wrap, and mixed vegetable bowl. Thus, blocks were designed to capture brain activation in response to a variety of different healthy foods and also highly palatable foods including those with combinations of high-sugar, high-fat, or high-sodium content.

MRI Data Analysis

MRI scans were analyzed using the FMRIB Software Library (FSL, v5.0, Oxford, UK). The Brain Extraction Tool (BET) of FSL was used to remove non-brain tissue from scan images and prepare them for analysis. Then, the FMRIB Easy Analysis Tool (FEAT) was used to conduct general linear modeling of the fMRI data.

The objective of fMRI analysis is to determine brain activation in response to image stimuli in four conditions: 1) healthy food images, 2) highly palatable food images, 3) healthy > highly palatable food images, and 4) highly palatable > healthy food images. To determine which areas of the brain are activated during the functional scans, a layering technique was used in the FSL program. The functional scan images are defined by 3-D units of spatial resolution known as voxels. Voxels range in size and represent a population of neurons. When blood flow increases within a voxel (indicating increased neuronal activity), the associated BOLD signaling response can be determined (Soares et al., 2016). The FSL program layers the functional scan images, showing activation in specific voxels, on top of the structural scan images to determine which brain region is activated by measuring changes in the voxels. To take the analysis one step further, the FSL cluster tool was used to form groupings of brain voxels with similar connectivity known as clusters (Soares et al., 2016). Cluster thresholding was conducted to define significant clusters using a minimum Z statistic of 2.3 after thresholding to a maximum Z statistic of 6.7. Cluster analysis is regularly used in fMRI and is a data driven statistical approach for testing brain activation in a unit larger than a voxel but smaller than entire brain region of interest (Heller et al., 2006; Soares et al., 2016). The results of this

analysis are described in terms of number of significant clusters identified for each of the four conditions, in the beginning and end of month scans.

Table 6

Outline of Block-Design of fMRI Image Stimuli

Block #	Types of Images and Group Theme
1	Non-food objects, *leaves*
2	Highly palatable food, *sweets/desserts*
3	Non-food objects, *household items*
4	Healthy food, *vegetables*
5	Non-food objects, *flowers*
6	Highly palatable food, *savory/mixed dishes*
7	Non-food objects, *animals*
8	Healthy food, *savory/mixed dishes*
9	Non-food objects, *animals*
10	Highly palatable food, *sweets/desserts*
11	Non-food objects, *household items*
12	Healthy food, *fruits*
13	Non-food objects, *household items*

Note: Each block contains 10 images

Table 7

Examples of Images Used in the fMRI for Each Block Condition[a]

Non-food objects			

Highly palatable food, *high-sugar or high-sugar and high-fat*			
Highly palatable food, *high-fat and high-sodium*			
Healthy food			

[a]All images sourced from the food-pics database of the Eating Behavior Laboratory, Centre for Cognitive Neuroscience and Department of Psychology, Hellbrunner Str. 34, 5020 Salzburg, Austria

Results

The socio-demographics for participants A and B are presented in Table 8. Both participants in this study had high levels of perceived stress compared to the stress scores of women participating in a nationally representative survey of 2000 adults in the U.S. where the mean perceived stress scale score for women was found to be 16.14 (SD= 7.56) (Cohen & Janicki-Deverts, 2012). Participant A was a 36-year-old woman experiencing very low food security, with a monthly income of $750 and also receiving SNAP and disability benefits. Participant A lived in a household with one other adult and no children. Participant A had a high perceived stress score of 25, and high scores for the total power of food scale score (4.20) and the subscale scores of food present (5.00) and food tasted (4.60, Figure 6). In the beginning of the month, participant A had poor overall

diet quality with a total HEI-2015 score of 36.64, which improved slightly to 42.49 in the end of the month.

Participant B was a 56-year-old woman experiencing very low food security with a monthly income of $1225, not participating in SNAP but receiving disability benefits. Participant B lived alone in a household with no other adults or children. Participant B had a high perceived stress score of 26, and a total power of food scale score of 3.34, with a lower score for the subscale food tasted (2.20) but higher scores for food present (4.00) and food available (3.83, Figure 6). In the beginning of the month participant B had greater overall diet quality with a total HEI-2015 score of 69.49, which declined in the end of the month to 53.91.

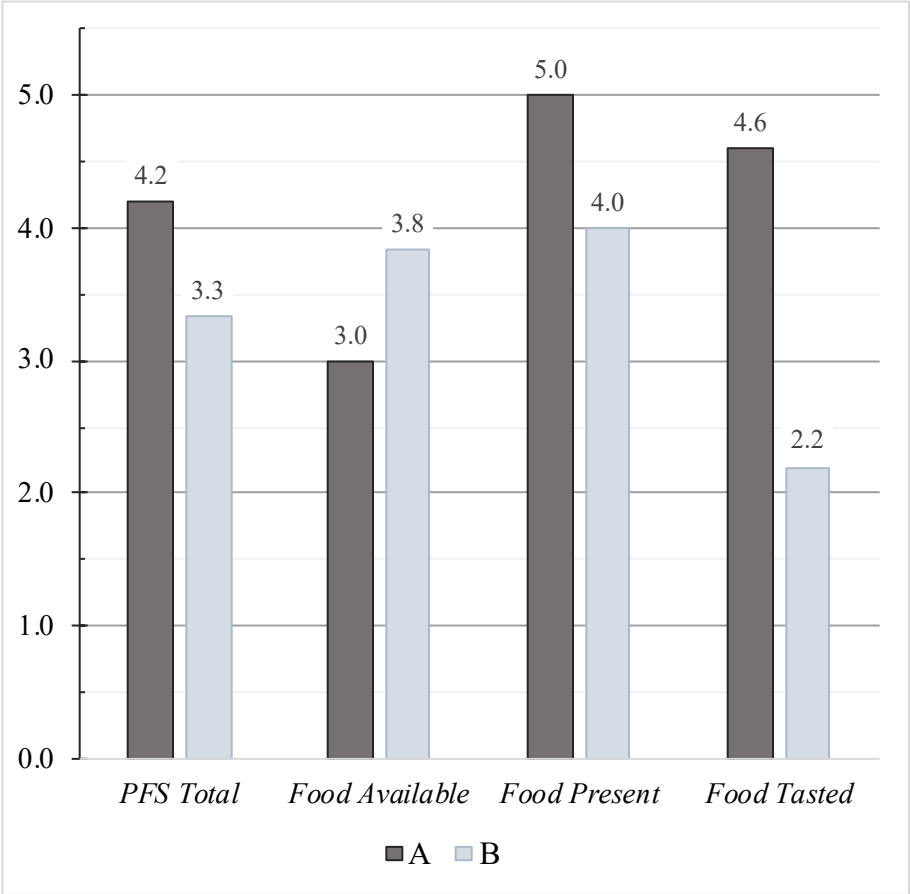
Table 8

Socio-Demographics of Two Women Experiencing Food Insecurity

	A	**B**
Age, *years*	36	56
Total Monthly Income	$750	$1225
Household Size, *number of people*	2	1
SNAP Participation	Yes	No
Perceived Stress Scale Score	25	27
Hunger Rating at MRI 1	5	7
Hunger Rating at MRI 2	5	1
HEI-2015 Total, Beginning of Month	36.64	69.49
HEI-2015 Total, End of Month	42.49	53.91

Figure 5

Comparison of Power of Food Scale Scores (n=2)



The number of total clusters significantly elevated in each condition for both participants in the beginning and end of month periods is given in Tables 8 and 9. Also provided are the functional groups for what processes the clusters and brain regions are related to (i.e. memory, sensory, cognitive, limbic). For participant A, the overall number of significant clusters in the beginning of the month was far lower than the end of month period. In the beginning of the month, participant A showed the greatest activation for the palatable foods category where 6 significant clusters were identified, compared to zero

clusters identified in the healthy foods condition, and only one cluster identified in both conditions for healthy over palatable foods, and palatable over healthy foods. However, in the end of the month participant A showed greater activation across each condition, with 7 significant clusters identified for palatable foods, 3 clusters for palatable over healthy foods, and 12 clusters for healthy food. Additionally, participant A also showed a significant increase in the end of month period for activation in brain regions associated with the limbic system, particularly in the condition for healthy over palatable foods. The heatmap of brain activation for this condition is shown in Figure 3.

Table 9

Cluster Activation for fMRI Conditions by Frequency, Participant A

	Beginning of the Month		***End of the Month***	
Condition	**Clusters**	**Related Functional Groupings**	**Clusters**	**Related Functional Groupings**
Palatable	6	memory, cognitive, sensory	7	memory, limbic, sensory
Healthy	0		12	limbic, cognitive, memory, sensory
Palatable > Healthy	1	limbic, sensory, cognitive	3	cognitive, sensory, memory
Healthy > Palatable	1	memory	13	memory, cognitive, limbic, sensory

The results for significant cluster activation identified for participant B in the beginning and end of the month tell a different story. In the beginning of the month, participant B had greater overall brain activation in terms of number of significant

clusters for the palatable and healthy foods condition. In comparison to the results from scans in the end of the month where brain activation for the palatable and healthy foods conditions both declined. For the condition of palatable foods over healthy foods, participant B had activation in brain regions largely associated with memory, cognitive, and sensory functions in the beginning of the month. Whereas in the end of the month, overall activation in this condition increased significantly, and a greater number of brain regions associated with the limbic system were identified in the end of the month. The heatmap of brain activation for this condition is shown in Figure 4. Further, in the beginning of the month, participant B's brain regions significantly activated in the healthy over palatable foods condition were more associated with limbic, cognitive, sensory, and memory processes. Whereas in the end of the month, a significant increase in activation overall was observed, and the brain regions identified were more closely associated with memory and cognitive processes than the sensory and limbic systems.

Table 10

Cluster Activation for fMRI Conditions by Frequency, Participant B

	Beginning of the Month		***End of the Month***	
Condition	**Clusters**	**Related Functional Groupings**	**Clusters**	**Related Functional Groupings**
Palatable	14	memory, cognitive, sensory, limbic	10	cognitive, memory, limbic
Healthy	14	cognitive, memory, sensory, limbic	6	sensory, cognitive, limbic, memory

Palatable > Healthy	6	memory, cognitive, sensory	12	memory, cognitive, limbic, sensory
Healthy > Palatable	6	limbic, cognitive, sensory, memory	11	memory, cognitive, limbic, sensory

In Table 11, we have identified notable brain regions they pertain to reward processing and visual food stimuli for each condition in the beginning and end of the month. Across the board for each condition of healthy, palatable, palatable over healthy, and healthy over palatable foods we identified a greater number of brain regions previously found to be associated with visual processing of food stimuli and reward in the end of the month compared to the beginning of the month. For example, in the palatable foods condition in the beginning of the month, participants were observed to have significant activation in the lingual gyrus, cingulate gyrus, and temporal lobe. Where in the end of the month, activation in relation to palatable foods shifted to the insula, inferior frontal gyrus, caudate, and frontal orbital cortex. In the palatable over healthy foods condition, increased activation was also observed in the end of the month period in the inferior temporal and frontal gyrus, cingulate gyrus, parahippocampal gyrus, insula, and thalamus. Notably, a major shift for both participants was observed from the beginning to the end of the month for activation in the healthy foods condition. For participant A, no significant clusters were identified in this condition in the beginning of the month, but in the end of the month this participant showed significant activation in the frontal orbital cortex, cingulate gyrus, inferior frontal gyrus, temporal lobe, L amygdala, L caudate, and L thalamus. And although participant B had overall greater

activation in the beginning of the month for healthy food condition and this declined in the end of the month, but in both periods this participant had significant activation in the insular cortex and insula.

Table 11

Selected Brain Regions Identified in fMRI Conditions in the Beginning and End of Month Periods (n=2)

Condition	***Beginning of the Month***	***End of the Month***
Palatable	L Hippocampus, Paracingulate gyrus, Lingual gyrus, GM insula, Temporal lobe, Frontal pole	Insula, Inferior frontal gyrus, Caudate, Frontal orbital cortex
Healthy	Insula, Insular cortex, Thalamus, L Thalamus	Inferior frontal gyrus, Insular cortex, Insula, L amygdala, Parahippocampal gyrus, Frontal orbital cortex, Centromedial amygdala, L caudate, Cingulate gyrus
Palatable > Healthy	Thalamus, Cingulate gyrus, Inferior temporal gyrus, Lingual gyrus, Paracingulate gyrus, Frontal pole	Inferior temporal gyrus, Inferior frontal gyrus, Cingulate gyrus, Insular cortex, Parahippocampal gyrus, Insula, Thalamus, L Thalamus
Healthy > Palatable	Frontal operculum cortex, Insular cortex, Insula, Cingulate gyrus, Paracingulate gyrus	Inferior temporal gyrus, Middle temporal gyrus, Middle frontal gyrus, L Thalamus, Thalamus, L amygdala, Parahippocampal gyrus, Parietal operculum cortex

Figure 6

Heatmap of Brain Activation for Participant A in Healthy Over Palatable Foods Condition from Beginning of the Month (Left Image) to the End of the Month (Right Image)

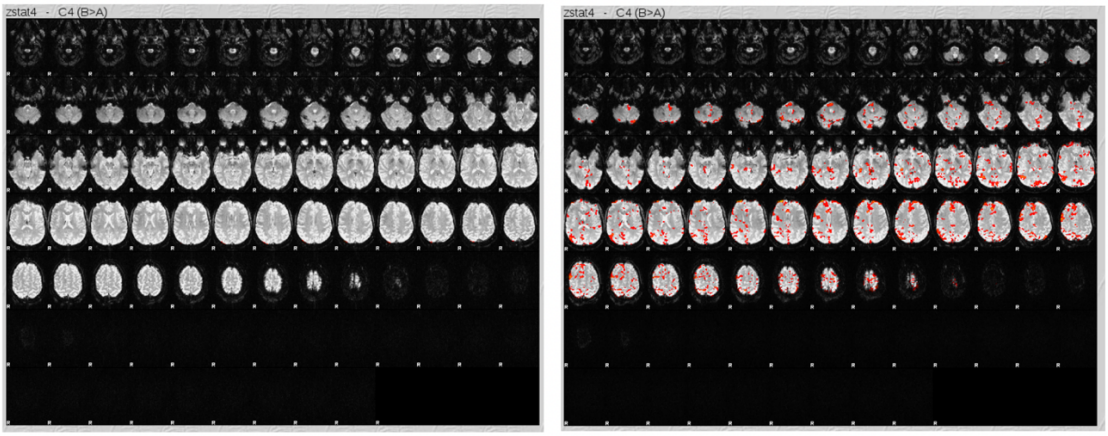
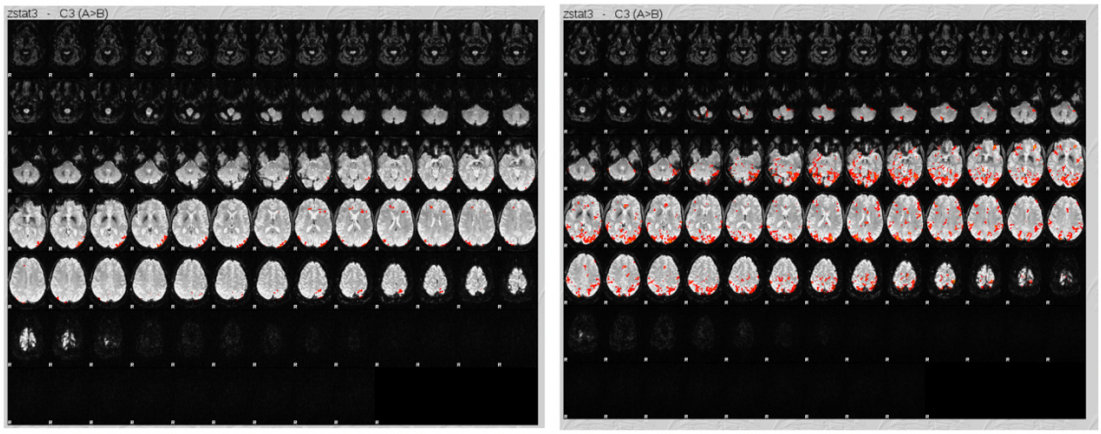


Figure 7

Heatmap of Brain Activation for Participant B in the Palatable Over Healthy Foods Condition from Beginning of the Month (Left Image) to the End of the Month (Right Image)



Discussion

The results of this case study indicate that fMRI neuroimaging is a potentially feasible method for evaluating brain activation for food stimuli in low-income food insecure adult women. This study was designed to allow for changes in food availability and diet quality according to participants' individual monthly schedule of income receipt. And, the fMRI scans were scheduled to capture participants' reactivity in the 'feast' period of adequate food and resources and in the 'famine' period of less resources and greater vulnerability in diet quality. Consequently, we identified changes in the overall amount of BOLD activation for palatable and healthy foods, and significantly activated brain regions associated with both. For example, we identified activation in the insula in the beginning of the month scans for healthy and healthy > palatable conditions and in the end of the month scans for palatable, healthy, and healthy > palatable conditions. The insula is a major brain region involved in encoding the sensory aspects of food, the reward value of foods, the taste and olfactory properties of foods, and is activated by cravings for a favorite food (Neseliler et al., 2017). Increased activation was also seen in the end of the month in the amygdala for the healthy and healthy > palatable foods conditions. A prominent structure in the limbic system, the amygdala also plays a role in emotional learning and encoding the sensory aspects of food, and is critically involved with attributing incentive value to food cues (Neseliler et al., 2017; Nestler, 2001).

In looking understanding participants' power of food scale scores, both participant A and B had elevated total scores. While there are no specific cut-points provided in the literature for interpreting high and low score values, research has found

that higher PFS scores indicate increased sensitivity to food reward and have previously been associated with greater food cravings and consumption (Espel-Huynh et al., 2018; Forman et al., 2007).

We also found significant changes among these two participants from the beginning to the end of the month, indicating the potential importance or utility of assessing fMRI for healthy and palatable foods at multiple time-points. This study utilizes fMRI as a novel approach for understanding differences in brain activation for visual food stimuli among women experiencing food insecurity. The implementation of fMRI in eating behaviors research has been profoundly valuable for understanding how differences in stress, motivation, hunger state, food intake, and other factors affect brain activation for varying food stimuli and for describing neurological correlates of food selection and eating behaviors (van der Laan et al., 2011). This work has important implications for community nutrition research, where individuals experiencing food insecurity have increased chronic stress, inconsistent access to food, and disrupted eating patterns all of which may influence neural processing of appetite and food reward. The extent to which neural processing of food cues influences eating behaviors, food choice, and weight outcomes is unknown in food insecurity. Thus, there is great opportunity in the translational use of fMRI in food insecurity research for furthering our understanding of the food insecurity and obesity paradox. Further study in this area could involve the use of fMRI to investigate the influence of the obesogenic food environment on neural processing of food cues in food insecurity. Such work may have serious implications for the development of behavioral interventions and public policy applications. In short,

fMRI has a number of potential applications in food insecurity and health disparities research which deserve further exploration.

However, there are some weaknesses or limitations to using the MRI in research, particularly among this population group. The present study is limited by its exploratory nature and small sample size. First, it is expensive, and may not be easily accessible for research staff and participants alike. Second, if safety rules and regulations are not followed, it can quickly become a dangerous situation for those involved, so extensive training of research staff is required. Additionally, participant population may be limited by those with contraindications for the MRI such as medical device implants, recent surgeries, etc. Participants may feel some claustrophobia or slight discomfort within the scanner, and thus may be disincentivized from completing multiple scanning sessions, although this was not a problem in the present study. Along with a financial incentive given for study completion, participants should be offered a copy of their scans for personal records when possible. The present study is limited by its exploratory nature and small sample size.

Conclusions

Our work has demonstrated that the use of fMRI for investigating brain activation in relation to visual food stimuli in food insecurity is feasible and may be an important area of future research. This case study also showed the importance of consideration of monthly income and benefits cycles in the design of fMRI research among participants experiencing food insecurity. Where standard procedures in fMRI research evaluate participants' hunger states and other factors for statistical control, work involving low-

income participants should also assess individual resource availability prior to or at the time of the scan as well as other factors related to stress. The use of fMRI techniques in food insecurity research is a viable approach for advancing the study of neurological regulation of eating behavior in overweight and obesity.

CHAPTER VI

EPILOGUE

Summary of Findings

The findings of this exploratory study culminate in several meaningful outcomes for the body of evidence investigating the food insecurity and obesity paradox among low-income women. Firstly, as suspected, the home food environment of availability, variety, and consistency of adequate foods was found to be particularly vulnerable to change in accordance with the income and benefits cycle. The findings for availability and variety of fresh fruits, fresh vegetables, and meats seem to be the most tenuous food items within the home food environment within in the month. This was corroborated by participants' own reports and qualitative feedback for questions regarding typical changes in the home food environment within the month. These results serve to demonstrate that multiple intra-monthly assessments of the home food environment are necessary for determining its significance in the food insecurity and diet quality pathway.

Second, in evaluating diet quality of participants during the beginning and end of month periods, the results showed an overall poor-quality diet as evidenced by the mean HEI-2015 scores of 45.2 in the beginning of the month and 50.8 in the end of the month. A closer assessment of HEI-2015 component scores revealed poor intake of nearly every adequacy food component, with the exception of total protein foods where participants had the greatest mean scores. This finding further serves to highlight the importance of

animal-based proteins in the typical diet of women in this study. In the end of the month period, participants consumed a greater percentage of total energy from carbohydrates and added sugars. There was also a relationship between perceived stress scale scores and intake of added sugar in the beginning of the month. Participants who were in the high stress group also had a significantly lower total diet quality score than those in the low stress group in the end of the month. The role of stress in diet quality is multi-faceted but may have a greater effect in participants' diets in the end of the month period when stress may be elevated, and food choices limited.

To address the third objective of this research, a case study approach was utilized, highlighting two participants who demonstrated changes in diet quality and the home food environment within the monthly period. Here, we noted significant individual differences in the overall activation for food stimuli in terms of number of clusters identified in each condition for the participants. Participant A had low brain reactivity in the beginning of the month, and a major increase in activity in the end of the month for the healthy, palatable over healthy, and healthy over palatable conditions. Participant B differed considerably across these conditions. Participant B had greater activation for palatable and healthy foods conditions in the beginning of the month, and in the end of the month shifted to increased activation in the palatable over healthy foods and healthy over palatable foods conditions. The use of fMRI in this manner with food insecure women is a novel approach not seen in the literature previously. Moreover, it is critical to know the feasibility of collecting brain scans from a difficult to sample population group. And, as seen in eating behaviors research, the visual food stimuli block-design approach

is suited to evaluating individual brain activation for a variety of food stimuli in this group.

Difficulties Encountered and Lessons Learned

By and large the greatest difficulty encountered throughout this work was recruitment of qualified and motivated participants. After achieving the independent operator certification for MRI from the Joint School in the summer of 2018, it took almost a full year before recruitment efforts started to pick up. This was due to a variety of factors. Initially the main recruitment strategy was to conduct in-person recruitment at EFNEP classes in Greensboro. This was successfully accomplished at only two EFNEP classes. Though we were under the impression our study was supported by the Guilford Co. Extension Office via the Director, and the Regional EFNEP Program Coordinator, there seemed to be a disintegration of communication with the EFNEP Peer Educator hosting the classes. Later in 2019 it was discovered that this person had left their position at the Extension Office and was no longer involved in EFNEP. Our recruitment priorities then shifted to increasing disbursement of study flyers in Greensboro and even on-campus recruitment via mass emails to UNCG staff. In the end, what became most successful was our word of mouth recruitment between participants. However, this experience demonstrated the importance of establishing a consistent community partnership and also utilizing multiple recruitment strategies if possible.

Another problem I encountered was in participants who were non-responsive to contact and did not complete a second telephone interview even though they had completed both MRIs. Of course, participant dropout is to be expected for a variety of

reasons, there may have been strategies that could have preempted this problem. Such as withholding the second gift card incentive until after all study assessments were completed or conducting the second interview in-person either before or after the MRI visit. However, due to the nature of the MRI suite and facilities at JSNN this did not seem like a feasible option due to multiple groups using the MRI during the same time period.

Lastly, a huge area of growth for me in this study was learning to operate the MRI independently and ultimately with confidence. This became critical as I welcomed participants to the research facility and acclimated them to the environment while trying to demonstrate control of the situation. I also believe that having the MRI facility located in a facility rather than a medical or clinical institution was a major asset in this study and allowed us to avoid any negative associations participants may have with health care environments. While the technical knowledge of the MRI was vital, it quickly became apparent that the soft-skills and inter-personal relationships with participants were just as important for achieving high-quality scans and encouraging participation in follow-up. There were many occasions throughout the study where we encountered technical problems with the MRI or other instruments in the MRI suite. Fortunately, the other research groups using the MRI at JSNN, specifically from the UNCG Kinesiology Department, were helpful and supportive in answering our questions and sharing tips, as was the Siemens MRI technician. We were also able to learn from the mistakes of others in this space, highlighting the importance of communication and collaboration between research teams. In learning to operate in the suite and magnet room with care and vigilance, we did not encounter any safety or health issues whatsoever.

Future Areas of Interest

I was fortunate in this doctoral research that my interests in food insecurity of vulnerable populations aligned so closely with my mentor, and, that I was involved heavily in every phase of the study conceptualization, and development. This experience further solidified my desire to continue working in food insecurity research and practice. Most compelling to me is the investigation of the 'mentality of scarcity' as it pertains to food insecurity. The mentality of scarcity describes the impact of multiple stressors of food insecurity, poverty, housing and job insecurity on biobehavioral mechanisms for increased cognitive burden, poor sleep and increased stress. These stressors which lead to physiological and hormonal response mechanisms result in an overall diminished cognitive capacity, and poor diet quality. To decrease the effects of food insecurity on diet quality, multi-level interventions and policy initiatives are required to ensure access to adequate and safe food for all people at all times. Further novel interventions may be developed which ameliorate the biobehavioral response mechanisms leading to the mentality of scarcity. I am interested in developing interventions which address multiple factors in the biobehavioral pathway.

In the future I would like to study the feast and famine cycle prospectively to assess severity over time. This has direct implications for informing the timing and distribution of food assistance benefits and could be altered to increase food security. Moreover, it is critical know whether the cyclical changes in food availability and diet quality are occurring in each month or if there is a pattern where intervening may be more successful.

In my opinion, the relationship between food insecurity, stress, and diet quality cannot be overstated. In future research, I would aim to utilize both self-reported measures of perceived stress, and other assessments of acute stress such as heart rate monitors and cortisol measurements. Broadly, I aim to include more objective and clinical-based assessments in my research of food insecurity. One way of doing this would be to continue to use fMRI to study brain activation in response to visual food stimuli. Although I would be interested in pursuing this research line further, this would require collaboration with other experts in neuroscience or physics to be successful. I do believe that the introduction of fMRI to eating behaviors research in food insecurity will be incredibly important for distinguishing between the environmental causes of disordered eating versus a pathological condition. Previous research on eating behaviors in food insecurity has suggested that food insecure women are at an increased risk for developing binge eating disorder. While I do not dispute this, I think there is a critical need to answer this question through high-quality and objective research methods.

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APPENDIX A

CONSENT FORM

CONSENT TO ACT AS A HUMAN PARTICIPANT

Project Title: An examination of neuro-behavioral pathway to study the relationship between food insecurity & obesity.
Project Directors: Dr. Steve Fordahl & Dr. Jigna M. Dharod

Participant's Name: _____

What is the study about?
This is a research project. This study is conducted to understand how food unaffordability or insecurity and inconsistency in home food supply affect liking to different types of food. We would like to know your food insecurity status, dietary habits, home food environment, and do your brain MRI to assess reactivity to foods. Your participation is voluntary.

Why are you asking me?
This study is specifically conducted with 18 yrs and older women who are involved in home food shopping.
In addition., for brain scanning or MRI--Magnetic Resonance Imaging-- purposes, you cannot be pregnant or possibly pregnant. MRI uses a very strong magnetic fields and powerful radio waves. While an MRI exam is safe for most people, there are a number of instances when it is unsafe (even potentially fatal) for someone to be in or around a MRI scanner. In order to make sure the MRI procedure will be safe for you, you will be asked to fill out a screening form before starting the study. It is important that you tell the researchers in this study:

- if you have a heart pacemaker
- if you have metal in your head (not including dental work)
- if you have metal in your spine or heart
- if there is the possibility of metal in your eyes,
- if you have any implanted medical device in your body,
- if you have an implant in your body held in place with a magnet,
- if you have had surgery in the last 6 weeks,
- if you weigh more than 450 pounds,
- if you are pregnant or there is the possibility that you are pregnant

What will you ask me to do if I agree to be in the study?
Before enrolling in the study you will be asked to answer a series of questions to determine if an MRI exam is safe for you. For instance, we are interested in knowing if you have any metal inside your body that could result in injury during the MRI exam. After it has been determined that it is safe for you to have an MRI exam, you will be asked to notify the days when you receive your paycheck or monthly food assistance or do major food shopping for your household. Based on that, we will determine two dates to do MRI and interviews. In other words, we will do MRI and interview two times in an approximately one-month period. The dates will be set up in alignment with the 'beginning' and 'end' of month. Interview & MRI 1 will be conducted within a week of the receipt of first paycheck/food assistance/time of major food shopping in a monthly cycle. While, Interview and MRI 2 will be conducted in 3 to 4 weeks from the first interview to capture 'end' of the month period.
Interviews will be conducted over the phone or in-person and will include questions to collect personal information such as your age, education, dietary habits, home food supply and food insecurity. The first interview will be long, but the second interview will only have questions to collect information on home food supply. Each interview should not take more than 1-1.5 hours. It is optional, but you will also be asked to click and send us pictures (by e-mail or phone) of your food pantry, refrigerator, freezer and place where food is kept.
For the MRI, you will be asked to come to the UNCG's MRI facility (2907 E. Gate City Blvd Greensboro NC 27401). For the **MRI visit, you will be asked to lie on a table and will be entered into the MRI scanner head first. You will first be asked to lie quietly while a series of structural/functional brain MR images are obtained.** For your safety, you will be monitored the entire time you are in the scanner. The study team will be able to talk to you and hear you talk during the

exam through an intercom. You will also be given a safety-ball to squeeze with your hand if you want to stop the exam at any time for any reason.

Each MRI visit will be about 1 hour and each interview will not take more than an hour and a half. Hence, the total duration of participation is about ***5 to 6*** hours (beginning of the month Interview and MRI = 2.5 hours + end of the month interview and MRI = 2.5 hours + travel time to the MRI center).

Is there any audio/video recording?
There will be NO audio or video recording.

What are the dangers to me?

There is a minimal risk for participating in this study, you may feel uncomfortable discussing food related issues with us.

MRI scanners have been in clinical use for about 20 years. When the MRI is used properly, there are no known risks to having an MRI scan for most people. Unlike X-rays, CT scans, and nuclear medicine studies, the MRI machine does not use X-rays or other forms of ionizing radiation. Instead, the MRI scanner uses strong magnetic fields and radio waves to measure your brain activity when you lay on a bed in a tube.

Metal objects: Metal objects within or on your body and clothing can cause harm to you, in addition to distorting the quality of the MRI images. Such things as keys, watches, and credit cards will be kept safely away from the machine. We will ask you to take off all removable metal (e.g. jewelry, piercings, etc.). People with devices or objects inside their body that are affected by strong magnetic fields (i.e. metallic foreign bodies inside your head or in your eyes, incompatible medical implants, pacemakers, brain stimulators, blood vessel clips, etc.) will not be allowed to participate under any circumstances. Knowingly participating in this study with these types of metallic implants can lead to serious injury or death. Although metal objects sensitive to strong magnetic fields are not allowed in the MRI scanner, there are many metal objects that are not sensitive to strong magnetic fields, such as dental work, pins or screws used during surgery, and even some tattoos contain metal. People with these types of metal objects may safely participate in this study. You will go through an extensive screening process to determine if the MRI scanner is safe for you before allowing have your MRI exam.

Burn risks: In extremely rare cases, metal in the body (e.g., in tattoos) exposed to the powerful radio waves used in MRI may heat up. This heating occurs gradually but if it goes unreported during the MRI exam it could lead to burns. Such burns are easily prevented by reporting any heating sensations that you have to the technologists immediately. For your safety, you will be monitored the entire time you are in the scanner. The study team will be able to talk to you and hear you talk during the exam through an intercom. You will also be given a ball to squeeze with your hand if you want to stop the exam immediately and for any reason.

Fear of small places: MRI machines require you to enter a tube about 2 feet in diameter and place your head in small helmet. For people with a fear of small spaces this can cause anxiety. If you experience anxiety during your MRI exam please let the technologist know. If you decide that you cannot complete the scan, you will be removed immediately from the scanner, and released from the study.

Hearing loss: MRI scanners when taking a picture are very loud. You will be required to wear earplugs during the exam. When the earplugs are used properly, the noise from the MRI scanner is as loud as a garbage disposal or food blender. If the earplugs are not inserted into the ear canal then temporary hearing loss is possible. If at any time the noise from the MRI machine is too loud inform the technologist.

Muscle twitching and tingling: MRI machines turn magnetic fields on and off very quickly to make an image. In rare cases, this may cause your muscles to twitch and tingle. The muscle twitching and tingling are temporary and will stop as soon as the scanner stops. In some rare cases, some individuals find the muscle twitching and tingling to be uncomfortable and cannot continue with the MRI exam. If this happens to you let us know and you will be released from the study.

Other miscellaneous risks: There are other short-term effects that have been reported in very rare cases during the MRI exam. These effects range from dizziness, to taste sensations, to light flashes during the MRI exam. These effects are temporary and occur as you move in and out of the MRI machine. In most cases, these effects go away very quickly. If these sensations persist and you are unable to continue with the MRI exam, inform the researchers and you will be removed from the MRI exam and released from the study. The MRI images completed at our facility are part of a research study and are not for clinical diagnostic purposes. The MRI images in this study will not be reviewed by a physician. If you would like to review these images with your physician, we will give you a free copy of your images on a CD. In the case that we see a substantial deviation from normal anatomy we will notify you, provide you with a free copy of your data, and suggest that you contact your physician for follow up. The research team cannot diagnose conditions.

Pregnancy: It is unclear at this time whether strong magnets are a risk to unborn fetuses. Due to the unknown risk and potential harm to an unborn fetus from any MRI scan, pregnant women will be excluded. All women will be asked before entering the scanner if they are pregnant.

The MRI images completed as part of this study are not for clinical diagnostic purposes. The MRI images in this study will not be reviewed by a physician. If you would like to review these images with your physician, we will give you a copy of your images on a CD.

If you have questions, want more information or have suggestions, please contact Dr. Steve Fordahl (scfordah@uncg.edu) or Dr. Jigna Dharod (jmdharod@uncg.edu). If you have any concerns about your rights, how you are being treated, concerns or complaints about this project or benefits or risks associated with being in this study please contact the Office of Research Integrity at UNCG toll-free at (855) 251-2351.

Are there any benefits to me for taking part in this research study?
There are no direct benefits to participants in this study.

What are the benefits to the study?
This study may benefit society by learning how the brain adapts to inconsistency in food supply. This could be beneficial for policy makers and clinicians in promoting healthy eating habits and preventing obesity among women.

Will I get paid for being in the study? Will it cost me anything?
After completing the first Interview + MRI, you will receive a gift card worth $50.00. Upon completion of second interview + MRI , you will receive a gift card worth $100.00 as an incentive. Hence, in total you will receive $150 worth gift cards upon completion of participation in the study (2 interviews, 2 MRIs).

How will you keep my information confidential?
All information obtained in this study is strictly confidential unless disclosure is required by law. Confidentiality will be maintained by means of participant coding. Specifically, all information obtained from you (brain imaging data and interview data) will be assigned a code number; your name will never be associated with the information obtained. The researchers listed above will use this number when analyzing, reporting, and (or) summarizing the information obtained from you; your name will never be identified.
Additionally, to further maintain your confidentiality; all obtained data will be stored in a locked file cabinet in a locked office, and any computer files will be stored on Box. Your name will be removed from all documents, a study code will be used in linking and analyzing data. An electronic master list of subject names and code numbers will be stored on the UNCG computer in a file directory separate from the data.

What if I want to leave the study?
You have the right to refuse to participate or to withdraw at any time, without penalty. If you do withdraw, it will not affect you in any way. If you choose to withdraw, you may request that any of your data which has been collected be destroyed unless it is in a de-identifiable state. The investigators also have the right to stop your participation at any time. This could be because you have had an unexpected reaction, or have failed to follow instructions, or because

the entire study has been stopped.

Voluntary Consent by Participant:
By signing this consent form you are agreeing that you read, or it has been read and explained to you, and you fully understand the contents of this document and are openly giving consent to take part in this study. All of your questions concerning this study have been answered. By signing this form, you are agreeing that you are 18 years of age or older and are agreeing to participate in this study described to you by _____.

Signature: _____ Date: _____

APPENDIX B

RECRUITMENT FLYER

Version Date: 4/11/19, IRB #17-0426

Research Study Participants Wanted:

Food and Brain Study (FoB)

UNC GREENSBORO

Department *of* Nutrition

If you are...

⇒ **An 18 years or older woman**

⇒ **Not pregnant, or likely to be pregnant, and not breastfeeding**

⇒ **And manage a household food budget**

Then you may be eligible to participate in a research study, if you meet certain income criteria, involving interviews and MRI scanning of the brain.

The purpose of this study is to understand the availability of foods at home and how that affects brain sensitivity to food.

This study will involve:

- 2 Interviews, ≈1.5 hour each
- 2 brain MRI scans at the UNCG and NC A&T Joint School of Nanoscience & Nanoengineering, ≈1.0 hour each

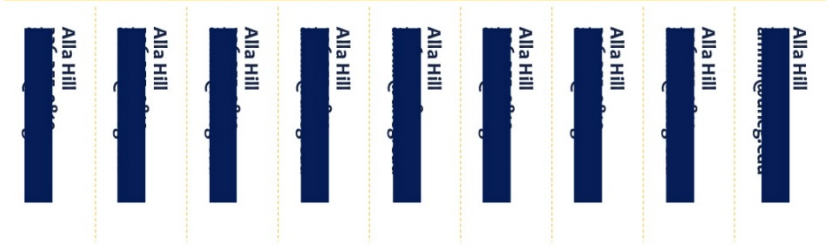
  Total about 5-6 hours of your time (including travel time to MRI facility)

For participation, you will receive a total of $150 in gift cards

- ***$50 gift card after MRI and Interview #1***
- ***$100 gift card after MRI and Interview #2***

Alla Hill

Have questions or are interested in participating?
Please call or message: [redacted]



APPENDIX C

PRE-SCREENING SURVEY

Pre-screening Survey Interviewed by (initials)_____

Participant Name: _____ Date _____

Contact Information
Primary Telephone Number: (_____)_____

Alternate Telephone Number (if applicable): (_____)_____

Address: _____

SCRIPT: First, I am going to ask you some questions to determine your basic eligibility to participate.
1. Are you a UNCG student or staff member?
   a. Student
   b. Staff
   c. Not a student or staff member

For Student:

What is your birthday (or year)	DOB:_____	If less than 18 years---- ineligible*
Do you live off campus?	o Yes o No	
Do you live off campus with roommate/s?	o Yes o No	
Are you the main food shopper/meal preparer/ or budgeting person of your household?	o Yes o No	If no--- Ineligible*
Have you received or eligible to receive federal Pell grant?	o Yes o No	If yes—eligible If no—must meet criteria below
Do you regularly use the on-campus food pantry or other food pantries in Greensboro?	o Yes o No	If no to all 4--- Ineligible* (or in other words, yes to any 4 questions makes student eligible for the study).
Do you receive SNAP (Food Stamps)?	o Yes o No	
Do you receive WIC?	o Yes o No	If yes, confirm it is for her children
Are the WIC benefits for your children?	o Yes o No	If no—Ineligible*

*Thank student for her time and interest.
Can you describe your living situation to me? Do you have a full kitchen in your home?

_____
_____
_____

Do you typically shop for groceries and prepare food at home, or do you have an on-campus meal plan? Do you share groceries with a roommate/dependent/partner? _____
_____
_____
_____

For Staff:

What is your birthday (or year)	DOB:_____	If less than 18 years---- ineligible*
Do you live off campus?	o Yes o No	If no--- Ineligible*
Do you live off campus with roommate/s? (excluding partners/kids)	o Yes o No	If yes--- Ineligible*
Are you the main food shopper/meal preparer/ or budgeting person of your household?	o Yes o No	If no--- Ineligible*
Do you regularly use the on-campus food pantry or other food pantries in Greensboro?	o Yes o No	Must participate in SNAP/WIC (for children), school programs (for children) or use food pantries to be eligible
Do you receive SNAP (Food Stamps)?	o Yes o No	
Do you receive WIC?	o Yes o No	If yes, confirm it is for her children
Are the WIC benefits for your children?	o Yes o No	If no—Ineligible*
Do you have children?	o Yes o No	
Do they participate in the school breakfast/lunch program?	o Yes o No	If no—must meet criteria for SNAP/food pantries

*Thank staff for her time and interest.

SCRIPT: I'm going to ask you some questions now that are required for the MRI safety evaluation.

Pre-screening Survey: Initial MRI Safety Check

Medications

1. Are you currently taking any medications? If so, what are they? ☐Yes ☐No
   a. List medications here: _____
      _____
   b. How long have you been taking these medications? _____
      _____

2. Do you experience any side effects from taking these medications that may make laying down in the MRI uncomfortable for you? ☐Yes ☐No

Note: Beta-blockers and diuretics may affect blood pressure but are not a contraindication. Psychoactive drugs may influence MRI results and should be noted for specific type and length of usage. If someone reports commonly experiencing side effects from these medications such as dizziness or other physical issues, they may not be comfortable in the MRI.

3. Are you pregnant or believe you may become pregnant within the next month? ☐Yes ☐No ☐Unsure/Don't Know

a. If YES or Unsure, "*Thank you for your interest in this study and for your time, but we are not able to include pregnant women in this project.*"

4. Are you currently breastfeeding? ☐Yes ☐No ☐Unsure/Don't Know

a. If YES or Unsure, "*Thank you for your interest in this study and for your time, but we are not able to include women that are currently breastfeeding in this project.*"

5. Have you had any surgery within the last 6 weeks? ☐Yes ☐No

a. If YES, *What was the surgery for, and when did the surgery occur*? *Was there any metal left in your body from the surgery?*

_____

_____

6. Do you currently wear a nicotine patch? ☐Yes ☐No

a. If YES, *We cannot ask you to remove the nicotine patch but if you are planning to remove the patch within the next month would you still like to participate*?

_____

7. Do you have any piercings or jewelry on your face or head that cannot be removed? ☐Yes ☐No

8. Do you have any metal on your head that cannot be removed? (ex. hearing devices, metal in hair extensions, etc.) ☐Yes ☐No

9. Do you have any metal objects implanted within your head or body? ☐Yes ☐No

a. If YES, *What is the object, and where in the body*?

_____

_____

10. Do you have an intrauterine device (IUD) implanted to prevent pregnancy? ☐Yes ☐No

a. If YES*, Do you know what type and brand of IUD*?

_____

_____

b. IUD is ☐MRI Safe, ☐MRI Conditional, ☐Unknown

Note for Interviewer: participant must know exact brand and type of IUD so we can review if it is MRI safe. If that information is unknown we cannot include them in the study. IUD must be safe at 3 tesla.

11. Do you have any tattoos on your upper body, head, or neck? ☐Yes ☐No

a. If YES, *Where*? _____

b. If YES, *How many*? _____

c. If YES, *How recent*? _____

12. Do you wear prescription eye glasses or contact lenses? ☐Glasses ☐Contacts ☐No

a. If YES (glasses), *Can you remove your glasses and still see well enough without them?* ☐Yes ☐No

b. If YES (both), *We will ask you to remove glasses during the MRI visit, can you bring contacts with you or wear them to the visit?* ☐Yes ☐No

Participant cleared for MRI Pre-screen? ☐Yes	☐No	☐Requires additional review

Note for Interviewer: YES responses to questions #2, 3, 4, 6, and 7, and NO responses to questions #11a and 11b, indicate the person does not meet inclusion criteria for MRI safety and therefore cannot be recruited for this study. YES responses to questions #1, 5, 6, 9, 11, and 12 require additional review to determine whether or not MRI safety criteria have been met. IUD devices should be confirmed with the table below, only devices that are safe at Strength 3 tesla shall be permitted. If interviewee meets all MRI safety criteria and study inclusion criteria, proceed with next section.

Additional Questions (not required for MRI safety)

1. Where did you hear about this study?
    a. A friend or family member who has participated referred me
        Name of the friend/family member: _____
    b. From a flyer in Greensboro
        Location of the flyer: _____
    c. From a UNCG email or posted flyer on campus
        ☐ Email ☐ Flyer on campus
        Location of the flyer:_____
    d. Other? Please specify: _____

2. *(For non-students and staff)* Do you identify as the main meal preparer in your household? Meaning, you shop for, make decisions about, and prepare most of the food in your household?
    a. Yes
    b. No, someone else is the primary meal preparer
    c. I'm not sure or I don't know
        Script: Can you explain this more? _____
_____

3. What is your main source of income & estimated total household income?_____

_____

4. When do you receive most of your monthly income? _____

_____

5. *For individuals receiving SNAP and WIC*, What day of the month do you usually receive SNAP or WIC benefits?

_____
_____

6. When are you available to complete the first MRI and interview?

_____

_____

Other Call Notes:

MRI #1 scheduled for:_____(day) at _____ (time)

Reminder phone call for MRI appointment #1:_____(day)

MRI #2 scheduled for:_____(day) at _____ (time)

Reminder phone call for MRI appointment #2:_____(day)

List of IUD Devices
(http://www.mrisafety.com/TheList_search.asp?s_list_description=IUD&s_ANYwords=&s_object_category=)

	Status	Strength
Contraceptive IUD MIRENA, polyethylene, barium sulfate Berlex Laboratories, Montville, NJ	Safe	1.5, 3
Contraceptive IUD Multiload Cu375 (copper, silver)	Safe	1.5
Contraceptive IUD Nova T (copper, silver)	Safe	1.5
Intrauterine contraceptive device (IUD), Copper T (copper) Searle Pharmaceuticals, Chicago, IL	Safe	1.5
Intrauterine Contraceptive Device (IUD) Liletta Intrauterine System Allergan, www.liletta.com	Safe	1.5, 3
Intrauterine Contraceptive Device (IUD) Lippey Loop, Plastic	Safe	1.5, 3
Intrauterine Contraceptive Device (IUD), Flexi-T 300, Flex-T +300, Flexi-T-380 IUD Trimedica, www.trimedic.com	Conditional 5	3
Intrauterine Contraceptive Device (IUD), Intrauterine System (IUS), Kyleena Bayer, www.bayer.com	Conditional 5	1.5, 3
Intrauterine Contraceptive Device (IUD), Jaydess Bayer, www.bayer.com	Conditional 5	3
Intrauterine Contraceptive Device IUD, Copper T 380A ParaGard, FEI, North Tanawanda, NY	Conditional 5	3
IUD, LCS Ultra Low Dose Levonorgestrel Contraceptive System Bayer Schering Pharma Oy, Turku, Finland	Conditional 6	3
Skyla Intrauterine Device, IUD Bayer Healthcare, www.Bayer.com	Conditional 5	3

Safe – The object is considered to be safe for the patient undergoing an MR procedure or an individual in the MR environment, with special reference to the highest static magnetic field strength that was used for the MR safety test. The object has undergone testing to demonstrate that it is safe or it is made from material(s) considered to be safe with regard to the MR environment (e.g., plastic, silicone, glass, etc.) or an MR procedure. Refer to additional information for the particular object indicated on this website.

Conditional 5 - This object is acceptable for a patient undergoing an MR procedure or an individual in the MR environment only if specific guidelines or recommendations are followed (see specific information for a given object on this website and contact the manufacturer for further information). Please refer to the specific criteria for performing the MR procedure by reviewing the information for the object on this website in the Safety Information section or on the manufacturer's website.. Consult the manufacturer of the particular device for the latest safety information. Frequently, this information is found on the company's website.

Conditional 6 - This implant/device was determined to be MR Conditional according to the terminology specified in the American Society for Testing and Materials (ASTM) International, Designation: F2503. Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment. Non-clinical testing demonstrated that the implant/device is MR Conditional. A patient with this implant/device can be scanned safely immediately after placement under the following conditions:

-Static magnetic field of 3-Tesla or less

-Maximum spatial gradient magnetic field of 720-Gauss/cm (a higher value for the spatial gradient magnetic field may apply if properly calculated).
-Maximum MR system reported whole-body-averaged specific absorption rate (SAR) of 2-W/kg for 15 minutes of scanning (per pulse sequence).

MRI-Related Heating: In non-clinical testing, the implant/device produced a temperature rise of less than or equal to 6.0 degrees C using an MR system reported, whole body averaged specific absorption rate (SAR) of 2-W/kg for 15-minutes (per pulse sequence) of scanning in a 3-Tesla MR system.
Artifact: MR image quality may be compromised if the area of interest is in the exact same area or relatively close to the position of the implant/device. In some cases, the artifact size relative to the size of the implant or device may be indicated.
Attention: Contact the manufacturer of this implant/device for further information, as needed.

Preparing for Your MRI Visit

Thank you for your time and help in participating in this project.

Your MRI is scheduled for (date) _____ at (time) _____

This list is to help you prepare for your MRI visit and to remind you of what we will be doing during that visit.

- For your own comfort, it is better to **wear loose-fitting and comfortable clothing to your visit**. You may also bring a change of clothes with you to the MRI visit and can change privately beforehand.
- During your MRI visit we will go through a safety screening with you. During that time we will ask you to **remove all jewelry on or around your face or head**.
- You will also be asked to **remove eye glasses** if you wear them. If you have contact lenses, we recommend that you wear those instead.
- We will ask you to remove your shoes before the MRI. For your comfort, we recommend that you **wear socks or bring a pair of socks with you**.

We estimate that your visit to the MRI center should take about 45 min. to complete. This visit should not take longer than 1 hour.

The MRI visit will occur at The Joint School of Nanoscience and Nanoengineering located at 2907 E Gate City Blvd, Greensboro, NC 27401

As you arrive at the Joint School you will see two buildings on the right, the second building is where we will meet for the MRI. Turn right at the first drive, and follow the road to the second parking lot. You may park your car there; you do not need a parking pass for this. Walk up to the second building and we will meet you at the front doors to let you in.

If you have questions or concerns about the MRI visit please contact: **Alla Hill,** [redacted]

APPENDIX D

PRE-MRI SURVEY

Date _____ **Start Time**_____ **End Time**_____

Participant ID _____ **Your Initials**_____

MRI Visit 1 or 2

1. Participant's last reported eating occasion/meal? _____

_____

2. Rate participant's reported level of hunger at time of MRI:

1 2 3 4 5 6 7 8 9 10

Not at all hungry *Somewhat hungry* *Extremely hungry*

3. Rate participant's reported level of anxiety at time of MRI:

1 2 3 4 5 6 7 8 9 10

Not at all anxious *Somewhat anxious* *Extremely anxious*

4. Can you rate your level of stress, in how you felt in general within the last week?

1 2 3 4 5 6 7 8 9 10

Not at all stressed *Somewhat stressed* *Extremely stressed*

*5. In terms of your last response for level of stress, can you explain your response? Was there any stress over the amount or variety of food available in the home?*_____

_____

_____

_____

Other notes:

_____

_____

_____

_____

APPENDIX E

FIRST INTERVIEW QUESTIONNAIRE

Interviewer Name:_____ Date:_____

Participant Name:_____ Participant ID:_____

Interview Start Time: _____ End Time:_____

Participant Contact Information

Address:_____

_____

Telephone Number:_____

Alternate Telephone Number: _____

Instructions for interviewer: Circle the answer that best corresponds to the participant's response. If a blank is listed next to an answer, such as "other _____" fill in the blank. If a participant does not want to answer a question just proceed to the next question. If a participant does not know the answer to a question, mark "don't know" for their response. Some questions will require that you read all possible responses to the participant, these will be marked by a **star**. Otherwise you may not need to read all possible responses to a question unless the participant needs a prompt.

*SCRIPT: Hello, I'm _____ calling on behalf of [**organization name**]. We are doing a survey and are asking questions about [**topic of survey questions**]. If you do not wish to answer a question you can say "I prefer not to answer". If you do not know the answer to a question just say, "I don't know". This survey is a part of the first interview, we expect this survey to take about 20 min., and no longer than 30 min.*

So, I will start with the socio-demographic questions.

PERSONAL INFORMATION & SOCIO-DEMOGRAPHICS

1. What is your date of birth? _____(mm)/_____(dd)/_____(YYYY)
2. What is your ethnicity?
   a. Non-Hispanic white
   b. Hispanic Origin
   c. African American
   d. Other (specify):_____
3. Do you have children?
   a. Yes
   b. No
4. How many children have you given birth to? _____
5. When was your last pregnancy? _____
6. **Where do you live right now?
   a. At your own home or apartment (not with parents, friends or relatives)
   b. With relatives, parents, or friends
   c. Other (specify):_____
   d. Wish not to answer
7. How many adults, including you, live in the house/apartment? _____

8. How many children aged 17 or younger, live with you in the house/apartment? _____

9. What is your current marital status?
   a. Single/never been married
   b. Married
   c. Living together (not married)
   d. Divorced
   e. Widowed
   f. Separated
   g. Other (specify): _____
   h. Wish not to answer

10. **Which of the following best describes your current employment status?
   a. Working full time (35 hours/week or more)
   b. Working part-time (less than 35 hours/week)
   c. Unemployed and looking for work
   d. Unemployed and not looking for work
   e. In school
   f. Own a business/partnership
   g. Other (specify): _____
   h. Don't know
   i. Wish not to answer

11. If **a, b, or f**, what is your monthly income (just your own):
   a. Specify: $_____
   b. Unsure
   c. Prefer not to say
   d. Other response? _____

12. What is the total monthly income for your household, which includes yours and income of other household members?
   a. Specify: $_____
   b. No income
   c. Unsure
   d. Prefer not to say
   e. Other response? _____

13. What is the highest grade level of school you have completed?
   a. Elementary (K-8)
   b. High School (9-12)
   c. Trade School
   d. Some college
   e. Associate's degree
   f. Bachelor's degree
   g. Master's degree
   h. Doctorate Degree (MD or PhD)
   i. Other _____

14. What is your most common method of transportation around town?
    a. Public Transit
    b. Taxi
    c. Personal car
    d. Rides from friends or family
    e. Walk
    f. Other (specify):_____

15. Do you have a driver's license?
    a. Yes
    b. No

16. Do you have your own car?
    a. Yes
    b. No

17. **(**NOTE**: ask this question for mothers of children only) Does your child (do your children) participate in any of the following programs?

    a. School Breakfast Program
        1. Yes
        2. No
        3. Don't Know
        4. Refused
    b. School Lunch Program
        1. Yes
        2. No
        3. Don't Know
        4. Refused
    c. Summer food program
        1. Yes
        2. No
        3. Don't Know
        4. Refused
    d. NC Health Choice
        5. Yes
        6. No
        7. Don't Know
        8. Refused

18. **Do you or any of the members in your household **use or visit**__***name of the program***_____ for food assistance: visit any of these food assistance programs?

    a. Food Pantries
        1. Yes
        2. No
        3. Don't Know
        4. Refused
    b. Soup Kitchens
        1. Yes
        2. No
        3. Don't Know
        4. Refused

19. ** Do you or any members of your household participate in _____ ?

    a. Cash assistance (TANF)
        1. Yes, If yes, How much per month? $_____/month
        2. No
        3. Don't Know
        4. Refused
    b. Supplemental Security Income Benefits (disability)
        1. Yes
        2. No

3. Don't Know
4. Refused

c. Medicaid (title 19)
   1. Yes
   2. No
   3. Don't Know
   4. Refused

d. Section 8 (rent or housing assistance)
   1. Yes
   2. No
   3. Don't Know
   4. Refused

SNAP and WIC

20. Do you receive SNAP ("Food Stamps")?
    a. **Yes
       1. For how long? _____months _____years
       2. How much in food stamps do you receive per month? $_____
       3. On what day of the month do you receive your food stamps? _____of every month
    b. No
21. Does anyone else in your household receive food stamps?
    a. **Yes
       1. How much in food stamps does this person/people receive per month? $_____
    b. No

22. **(**NOTE**: ask this question for mothers of children only) Do you get WIC vouchers for your children?
    a. **Yes
       1. For how many children? _____
       2. Around what time of the month (or which week of the month), do you normally use the WIC card or get the WIC food?_____
       3. What WIC food items do you use the most? _____
          _____
       4. When was the last time you use the WIC card or bought the WIC food?
          _____
    b. No

TOBACCO, ALCOHOL, DRUG USE

SCRIPT: The next few questions are about drugs, alcohol, and tobacco.

23. Do you smoke?
    a) Yes
       i. If YES, Within the last 2 weeks, on average, how often did you smoke cigarettes or e-cigarettes? _____ # times per day or week (circle)
    b) No, I do not smoke
    c) Other _____

24. Do you drink alcohol
   a) Yes
      i. If YES, Within the last 2 weeks, on average, how often did you drink alcohol/alcoholic beverages _____ # times per day or week (circle)
   b) No, I do not consume alcohol

25. Within the last two weeks, have you used any recreational drugs such as marijuana or other stimulants such as methamphetamines or cocaine?
   a) No, I do not use any recreational drug
   b) No, I have not used in the last two weeks
   c) **Yes
      i. Type(s):_____
      ii. How often in a week? _____
   d) Other _____

26. Do you consume any caffeinated drinks such as coffee, tea, sodas, or other?
   a) No, I do not consume any caffeinated drinks
   a) **Yes
      i. What type(s)? :_____
      ii. How often in a day/week? _____ circle: day/week
   b) Other _____

USDA HOME FOOD SECURITY SURVEY MODULE

Household Stage 1: Questions HH2-HH4 (asked of all households; begin scale items).

[IF SINGLE ADULT IN HOUSEHOLD, USE "I," "MY," AND "YOU" IN PARENTHETICALS; OTHERWISE, USE "WE," "OUR," AND "YOUR HOUSEHOLD."]

HH2. *SCRIPT: Now I'm going to read you several statements that people have made about their food situation. For these statements, please tell me whether the statement was* ***often true, sometimes true, or never true for (you/your household) in the last 12 months—that is, since last (name of current month).***

**The first statement is "(I/We) worried whether (my/our) food would run out before (I/we) got money to buy more." Was that often true, sometimes true, or never true for (you/your household) in the last 12 months?

a. Often true
b. Sometimes true
c. Never true
d. Don't Know or Refused

HH3. ** "The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

a. Often true
b. Sometimes true
c. Never true
d. Don't Know or Refused

HH4. ** "(I/we) couldn't afford to eat balanced meals." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

a. Often true
b. Sometimes true
c. Never true
d. Don't Know or Refused

Screener for Stage 2 Adult-Referenced Questions: **If affirmative response (i.e., "often true" or "sometimes true") to one or more of Questions HH2-HH4, then continue to Adult Stage 2**; **otherwise, if children under age 18 are present in the household, skip to Child Stage 1, otherwise skip to End of Food Security Module**.

Adult Stage 2: Questions AD1-AD4 (asked of households passing the screener for Stage 2 adult-referenced questions).

AD1. In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?

a. Yes
b. No (Skip AD1a)
c. Don't Know (Skip AD1a)

AD1a. ** [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

a. Almost every month
b. Some months but not every month
c. Only 1 or 2 months
d. Don't Know

AD2. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?

a. Yes
b. No
c. Don't Know

AD3. In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food?

a. Yes
b. No
c. Don't Know

AD4. In the last 12 months, did you lose weight because there wasn't enough money for food?

a. Yes
b. No
c. Don't Know

Screener for Stage 3 Adult-Referenced Questions: If affirmative response to one or more of questions AD1 through AD4, then continue to Adult Stage 3; otherwise, if children under age 18 are present in the household, skip to Child Stage 1, otherwise skip to End of Food Security Module.

Adult Stage 3: Questions AD5-AD5a (asked of households passing screener for Stage 3 adult-referenced questions).

AD5. In the last 12 months, did (you/you or other adults in your household) ever not eat for a whole day because there wasn't enough money for food?

a. Yes
b. No (Skip AD5a)
c. Don't Know (Skip AD5a)

AD5a. ** [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

a. Almost every month
b. Some months but not every month
c. Only 1 or 2 months
d. Don't Know

Child Stage 1: Questions CH1-CH3 (Transitions and questions CH1 and CH2 are administered to all households with children <18 y.)
NOTE: Ask these questions to households with child/children under 18 years ONLY. Households with no child under 18 y., skip to End of Food Security Module.
Select appropriate fills depending on number of adults and number of children in the household.

SCRIPT: Now I'm going to read you several statements that people have made about the food situation of their children. For these statements, please tell me whether the statement was OFTEN true, SOMETIMES true, or NEVER true in the last 12 mo. for (your child/children living in the household who are under 18 y.).

CH1. "I/We relied on only a few kinds of low-cost food to feed (my/our) child/the children because I was/we were running out of money to buy food." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

a. Often True
b. Sometimes true
c. Never true
d. DK or Refused

CH2. "(I/We) couldn't feed (my/our) child/the children) a balanced meal, because (I/we) couldn't afford that." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

a. Often True
b. Sometimes true
c. Never true
d. DK or Refused

CH3. "(My/Our child was/The children were) not eating enough because (I/we) just couldn't afford enough food." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

a. Often True
b. Sometimes true
c. Never true
d. DK or Refused

Screener for Stage 2 Child Referenced Questions: **If affirmative response (i.e., "often true" or "sometimes true") to one or more of questions CH1-CH3, then continue to Child Stage 2; otherwise skip to End of Food Security Module.**

Child Stage 2: Questions CH4-CH7 (asked of households passing the screener for stage 2 child-referenced questions).

CH4. In the last 12 months, since (current month) of last year, did you ever cut the size of (your child's/any of the children's) meals because there wasn't enough money for food?

a. Yes
b. No
c. Don't Know

CH5. In the last 12 months, did (any of the children) ever skip meals because there wasn't enough money for food?

a. Yes
b. No (Skip CH5a)
c. Don't Know (Skip CH5a)

CH5a. ** [IF YES ABOVE ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

a. Almost every month
b. Some months but not every month
c. Only 1 or 2 months
d. Don't Know

CH6. In the last 12 months, (was your child/were the children) ever hungry but you just couldn't afford more food?

a. Yes
b. No
c. Don't Know

CH7. In the last 12 months, did (your child/any of the children) ever not eat for a whole day because there wasn't enough money for food?

a. Yes
b. No
c. Don't Know

PERCEIVED FOOD SECURITY OVER TIME

27. I have asked all the statements in reference to last 12 months, but have you experienced these issues, that is worried about food affordability, and food shortage previously?
    a. Yes
        i. If so, for how long? _____ (in months or years) OR Since when_____
        ii. Could you please explain_____
        _____
        _____
    a. No
    b. Unsure/Don't know
    c. Prefer not to say

What was your experience growing up, in reference to food access/affordability?

28. Did you experience food shortage growing up?
    a. Yes
    b. No
    c. Unsure/Don't know
    d. Prefer not to say

29. If YES to #28, Which of the statements I am going to read best describes the food situation growing up?:
    a. Enough of the kinds of food we want to eat, but always or often worried about next month or uncertainty
    b. Enough but not always the kinds of food we wanted
    c. Sometimes did not have enough to eat
    d. Often did not have enough to eat
    e. DK or Refused

30. If YES to #28, *How old were you when you first realized or experienced food shortage/worry over ability to purchase food?*
    a. _____years
    b. Unsure/Don't Know
    c. Prefer not to say

32. (For all participants) Overall, please could you explain your food situation growing up? In terms of having enough food, having a variety of food, etc. _____
_____
_____
_____

FOOD PURCHASING AND HOME FOOD ENVIRONMENT

SCRIPT: The next section is about your food shopping patterns throughout a typical month.

33. Who in your household does most of the food shopping?
    a. Myself
    b. My spouse/significant other
    c. Parent or relative
    d. Other _____

34. ** Now, I will ask you about where you shop for food and how often.

Do you do food shopping, or do you buy groceries at….		If yes, how frequently	Any comments
The regular grocery stores (ex. Food Lion)	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	
Supermarket (ex. Wal-Mart)	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	
Convenience Store (ex. Stop-n-shop, gas stations)	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	
Drug Store (ex. CVS)	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	
Small Discount Store (ex. Dollar Tree)	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	
Small ethnic markets	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	
Farmer's markets	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	
Other? Type/Name:	o Yes o No	_____ a week _____ a month _____ < once/month Other _____	

35. How do you usually travel to the grocery store?
    a. Specify: _____

36. How long does it take you to travel to a grocery store or supermarket?
    a. _____minutes
37. Do you change where you shop based on how much money you have to spend?
    a. Yes
        i. If Yes, *Can you explain this more?* _____
    b. No
        i. If No, *Can you explain this more?* _____
    c. Unsure
    d. Prefer not to say
38. Would you say that you shop at different types of stores at the beginning of the month versus the end of the month?
    a. Yes
        i. If Yes, *Can you explain this more?* _____
    b. No
        i. If No, *Can you explain this more?* _____
    c. Unsure
    d. Prefer not to say
39. Do your attitudes or feelings about the amount of food you have available change throughout the month?
    a. Yes
        i. If Yes, *Can you explain this more?* _____
    b. No
        i. If No, *Can you explain this more?* _____
    c. Unsure
    d. Prefer not to say
40. Do your attitudes or feelings about the variety and types of foods you have available change throughout the month?
    a. Yes
        i. If Yes, *Can you explain this more?* _____
    b. No
        i. If No, *Can you explain this more?* _____
    c. Unsure
    d. Prefer not to say
41. Do you worry about the amount of food you have in the home throughout the month?
    a. Yes
        i. If Yes, *Can you explain this more?* _____
    b. No

i. If No, *Can you explain this more?* _____
_____

c. Unsure
d. Prefer not to say

42. Do you ever feel like you run out of food towards the end of the month?
    a. Yes
        i. If Yes, *Can you explain this more?* _____
        _____
    b. No
        i. If No, *Can you explain this more?* _____
        _____
    c. Unsure
    d. Prefer not to say
43. What is your estimated monthly budget for food?
    a. Specify: $_____
    b. Unsure
    c. Prefer not to say
44. Do you have a functional refrigerator in your home to store cold foods?
    a. Yes
    b. No
    c. Usually, but not right now
45. Do you have a functional freezer in your home to store frozen foods?
    a. Yes
    b. No
    c. Usually, but not right now
46. Do you have a functional stove and/or oven in your home to prepare hot foods?
    a. Yes
    b. No
    c. Usually, but not right now

PERCEIVED STRESS SCALE

SCRIPT: This next section is about stress. I will ask you questions and you will answer based on frequency. The possible answers are "never", "almost never", "sometimes", "fairly often", or "very often".

Perceived Stress Scale	**Never**	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**
1. In the last month, how often have you been upset because of something that happened unexpectedly?	(0)	(1)	(2)	(3)	(4)
2. In the last month, how often have you felt that you were unable to control the important things in your life?	(0)	(1)	(2)	(3)	(4)
3. In the last month, how often have you felt nervous or stressed?	(0)	(1)	(2)	(3)	(4)
4. In the last month how often have you felt confident about your ability to handle your personal problems?	(0)	(1)	(2)	(3)	(4)
5. In the last month, how often have you felt that things were going your way?	(0)	(1)	(2)	(3)	(4)
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	(0)	(1)	(2)	(3)	(4)
7. In the last month, how often have you been able to control irritations in your life?	(0)	(1)	(2)	(3)	(4)
8. In the last month, how often have you felt that you were on top of things?	(0)	(1)	(2)	(3)	(4)
9. In the last month, how often have you been angered because of things that happened that were outside of your control?	(0)	(1)	(2)	(3)	(4)
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	(0)	(1)	(2)	(3)	(4)
Scoring: Reverse score items 4, 5, 7, 8 (0 → 4, 1 → 3, 2 → 2, 3 → 1, 4 → 0) Sum all Perceived Stress Items and Reverse Score Items =_____					

POWER OF FOOD SCALE [REDACTED]

Power of Food Scale, © 2006 Drexel University, Michael Lowe

THREE-FACTOR EATING QUESTIONNAIRE (18 ITEMS)

SCRIPT: This next section is about eating behaviors. I will read these statements and the possible responses, and then you will answer with the frequency with which you find yourself feeling or experiencing what is described in the statements.

1. **When I smell a delicious food, I find it very difficult to keep from eating, even if I have just finished a meal.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

2. **I deliberately take small helpings as a means of controlling my weight.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

3. ** When I feel anxious, I find myself eating.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

4. **Sometimes when I start eating, I just can't seem to stop.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

5. **Being with someone who is eating often makes me hungry enough to eat also.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

6. **When I feel blue, I often overeat.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

7. **When I see a real delicacy, I often get so hungry that I have to eat right away.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

8. **I get so hungry that my stomach often seems like a bottomless pit.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

9. **I am always hungry so it is hard for me to stop eating before I finish the food on my plate.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

10. **When I feel lonely, I console myself by eating.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

11. **I consciously hold back at meals in order not to weight gain.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

12. **I do not eat some foods because they make me fat.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

13. **I am always hungry enough to eat at any time.
   Definitely true (4) *Mostly true (3)* *Mostly false (2)* *Definitely false (1)*

14. **How often do you feel hungry?
Only at meal times (1) *Sometimes between meals (2)* *Often between meals (3)* *Almost always (4)*

15. **How frequently do you avoid "stocking up" on tempting foods?
   Almost never (1) *Seldom (2)* *Moderately likely (3)* *Almost always (4)*

16. **How likely are you to consciously eat less than you want?

Unlikely (1) *Slightly likely (2)* *Moderately likely (3)* *Very likely (4)*

17. **Do you go on eating binges though you are not hungry?
Never (1) *Rarely (2)* *Sometimes (3)* *At least once a week (4)*

18. On a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

_____

APPENDIX F

HOME FOOD ENVIRONMENT SURVEY 1

Home Food Environment Telephone Survey (#1)

Interviewer Name:_____ Date:_____

Participant Name:_____ Participant ID:_____

Participant Date of Birth: _____

Interview Start Time: _____ End Time:_____

What week of the month is it? ☐First, ☐Second, ☐Third, ☐Fourth Week

Fast Food Frequency

1. In the last 5 days, how many times have you eaten fast foods (think of all the meals, breakfast/lunch/dinner/snacks etc.)? _____# of times

First, I am going to ask you about fresh fruits and vegetables you have in the home. Please look in any area of the house or kitchen that you keep fresh fruits and vegetables such as the refrigerator, on counter tops, in cabinets, on the dining table, and other places.

*Do you have any **fresh fruit** in your home?* ☐Yes ☐ No

If YES, *Can you tell me what types of **fresh fruit** you have in the home?*

Fruits		***How much or how many?***
Apples	☐ Yes ☐ No	
Bananas	☐ Yes ☐ No	
Blueberries	☐ Yes ☐ No	
Grapes	☐ Yes ☐ No	
Grapefruit	☐ Yes ☐ No	
Lemons or limes	☐ Yes ☐ No	
Melons (ie. Watermelon)	☐ Yes ☐ No	
Nectarines	☐ Yes ☐ No	
Oranges	☐ Yes ☐ No	
Pears	☐ Yes ☐ No	

Peaches	☐ Yes ☐ No	
Strawberries	☐ Yes ☐ No	
Tangerines/clementines	☐ Yes ☐ No	
Others?	☐ Yes ☐ No	

*Do you have any other **fresh fruits** that I did not ask about, in your home? Maybe in the cabinets, or in the fridge?* ☐ Yes ☐ No

Others:	**Amount:**

Now I am going to ask you about the fresh vegetables you have in the home. Please look anywhere you generally keep fresh vegetables such as the refrigerator, in cabinets, on countertops, or other places.

*Do you have any **fresh vegetables** in your home?* ☐Yes ☐No

If YES, *Can you tell me what types of **fresh vegetables** you have in the home?*

Vegetables		***How much, or, how many?***
Asparagus	☐ Yes ☐ No	
Beets	☐ Yes ☐ No	
Bell Peppers (any color)	☐ Yes ☐ No	
Broccoli	☐ Yes ☐ No	
Cabbage	☐ Yes ☐ No	
Cauliflower	☐ Yes ☐ No	
Carrots	☐ Yes ☐ No	
Celery	☐ Yes ☐ No	

Corn	☐ Yes ☐ No	
Cucumbers	☐ Yes ☐ No	
Green beans	☐ Yes ☐ No	
Lettuce	☐ Yes ☐ No	
Mushrooms	☐ Yes ☐ No	
Peas	☐ Yes ☐ No	
Potatoes	☐ Yes ☐ No	
Spinach (or other greens)	☐ Yes ☐ No	
Squash	☐ Yes ☐ No	
Sweet Potatoes	☐ Yes ☐ No	
Tomatoes	☐ Yes ☐ No	
Others?	☐ Yes ☐ No	

*Do you have any other **fresh vegetables** in your home? Maybe in the cabinets, or in the fridge?* ☐Yes ☐No

Others:	**Servings/Amount:**

Do you have a refrigerator in the home? ☐ Yes ☐ No

If YES, *Now I'm going to ask you about the types of foods you have inside the fridge. First, do you have any cheeses in the fridge?* ☐ Yes ☐ No

Cheeses		***How much? (Package label or estimation)***

Block	☐ Yes ☐ No	
Shredded	☐ Yes ☐ No	
Sliced	☐ Yes ☐ No	
String cheese	☐ Yes ☐ No	
Ricotta or cottage cheese	☐ Yes ☐ No	
Cream cheese, Neufchatel	☐ Yes ☐ No	
Cheez whiz, velveeta, or other canned cheese	☐ Yes ☐ No	
Other?	☐ Yes ☐ No	

Next, I want to ask if you have any other dairy products in the home? ☐ Yes ☐ No
If YES, *Can you check the places where you keep dairy products such as the refrigerator or freezer?*

Other Dairy Products		***How much? (Package label or estimation)***
Milk (specify % fat)	☐ Yes ☐ No	
Half and half or heavy cream	☐ Yes ☐ No	
Yogurt or yogurt drinks	☐ Yes ☐ No	
Other?	☐ Yes ☐ No	

Now I'm going to ask you about the different fats or oils you may have in the home. Can you please look around in the cabinets, on the countertop, and in the fridge for these items?

Fats and Oils		***How much? (refer to package label or portion estimate)***
Butter (regular or light)	☐ Yes ☐ No	
Margarine	☐ Yes ☐ No	
Lard or shortening	☐ Yes ☐ No	

Oils (specify type) Olive, canola, vegetable, coconut	☐ Yes ☐ No	
Other?	☐ Yes ☐ No	

Next I'm going to ask you about different meats you may have in the home. Can you look in the fridge or freezer for these items?

Meats		***Specific type of meat?***	***Amount? (package label or portion estimate)***
Deli meats Sliced turkey or chicken	☐ Yes ☐ No		
Sliced bologna, salami	☐ Yes ☐ No		
Sliced ham, beef	☐ Yes ☐ No		
Sausage, pepperoni	☐ Yes ☐ No		
Bacon	☐ Yes ☐ No		
Hot dogs, bratwurst	☐ Yes ☐ No		
Ground beef (regular, lean, extra lean)	☐ Yes ☐ No		
Pork (pork roast or pork chop)	☐ Yes ☐ No		
Chicken (with or without skin) (specify: pieces, "legs, wings, breasts, etc.")	☐ Yes ☐ No		
Turkey (with or without skin) (specify pieces)	☐ Yes ☐ No		
Others?	☐ Yes ☐ No		

Was that all the different meats you have in the home in both the fridge and the freezer? ☐ Yes ☐ No

If NO, *What other meats are there in the home that we did not already mention?*

Others?	☐ Yes ☐ No	***Type?***	***Amount?***

Next, I want to ask you about fish and other types of protein that you may have in the home. Can you please look in the fridge, freezer, and cabinets for these items?

Fish & Other Protein		***Specific type?***	***How much or how many? (package label portion estimate, or count)***
Fish	☐ Yes ☐ No		
Shellfish	☐ Yes ☐ No		
Tofu, tempeh	☐ Yes ☐ No		
Beans, Lentils	☐ Yes ☐ No		
Eggs	☐ Yes ☐ No		
Peanut Butter (or other nut butter)	☐ Yes ☐ No		
Nuts	☐ Yes ☐ No		
Other Protein?	☐ Yes ☐ No		

Do you have any foods that are already prepared such as mixed dishes? Think of things like casseroles, soups, or other combination dishes. Please look for these items in the fridge, freezer, or cabinets.

Prepared foods/Mixed Dishes		***Can you describe the amount using portion sizes or package labels?***
Type/Major Ingredients:	☐ Yes ☐ No	
Type/Major Ingredients:	☐ Yes ☐ No	
Type/Major Ingredients:	☐ Yes ☐ No	

Others?	☐ Yes ☐ No	

Next I want to know what types of beverages you have in the home. Can you look for these in the fridge, on the countertops, in cabinets, or anywhere else you may keep these items?

Beverages		***Specific type?***	***Amount? Refer to package label or portion size.***
Sodas	☐ Yes ☐ No		
Iced tea, lemonade	☐ Yes ☐ No		
100% Fruit juice	☐ Yes ☐ No		
Other fruit Juice drinks (such as Cool-aid, sunny delight etc.)	☐ Yes ☐ No		
Sports drinks	☐ Yes ☐ No		
Other drinks? (such as red bull)	☐ Yes ☐ No		

I've asked you about some things you might keep in the freezer but I want to know if you have any of these other frozen foods.

Desserts		***Specific type?***	***How much or how many? (package label portion estimate)***
Sherbet, sorbet	☐ Yes ☐ No		
Fruit juice bars, popsicles	☐ Yes ☐ No		
Rice or soy desserts	☐ Yes ☐ No		
Ice cream	☐ Yes ☐ No		
Other frozen dairy products (ie. Custard, yogurt):	☐ Yes ☐ No		

Other desserts:	☐ Yes ☐ No		
Microwaveable/Quick-Cook Foods:			
Pizza	☐ Yes ☐ No		
Hot Pockets	☐ Yes ☐ No		
Pizza Rolls, bagel bites	☐ Yes ☐ No		
Burritos, taquitos, etc.	☐ Yes ☐ No		
French fries, tater tots, hashbrowns	☐ Yes ☐ No		
Egg rolls, Asian food items	☐ Yes ☐ No		
Chicken nuggets	☐ Yes ☐ No		
Other quick-cook:	☐ Yes ☐ No		

Are there any frozen fruits or vegetables in the freezer? ☐ Yes ☐ No
If YES, *Can you tell me more about the frozen fruit and/or vegetables. What types do you have?*

Frozen fruits or vegetables	***How much or how many do you have?***
(list items)	

Is there any other food in the freezer that you did not mention already? ☐ Yes ☐ No
If YES, *Can you please tell me which foods in the freezer we did not cover?*

Other frozen foods:	

Is there any other food in the fridge that you did not mention already? ☐ Yes ☐ No
If YES, *Can you please tell me which foods in the fridge we did not cover?*

Other fridge foods:	

Now that we have covered all the foods that are kept in the fridge and freezer, I want to ask you about foods that do not need to be stored cold/frozen. These foods may be in your cabinets, pantry, on counter tops, or other places.
First, do you have any bread products? ☐ Yes ☐ No

Bread		***How many slices or items? Use package label or count***
Wheat bread or rolls	☐ Yes ☐ No	
White bread or rolls	☐ Yes ☐ No	
English muffins (wheat or white)	☐ Yes ☐ No	
Bagels (wheat or white)	☐ Yes ☐ No	
Tortillas (wheat, flour, corn)	☐ Yes ☐ No	
Pita bread (wheat or white)	☐ Yes ☐ No	
Croissants or baked breads (ex. biscuits)	☐ Yes ☐ No	
Other breads?	☐ Yes ☐ No	

Now I want to ask you about any cereals, rice, or pasta you might have.

Cereals, rice, pasta		***How much or how many servings?***
Corn flakes	☐ Yes ☐ No	

Rice cereals	☐ Yes ☐ No	
Bran cereal	☐ Yes ☐ No	
Chocolate cereals	☐ Yes ☐ No	
Fruit flavored cereal	☐ Yes ☐ No	
Other cereals?	☐ Yes ☐ No	
Rice (white, brown, yellow)		
Quinoa, bulgar, barley	☐ Yes ☐ No	
Other dried grain products?	☐ Yes ☐ No	
Pasta (whole wheat, white) Spaghetti, macaroni, penne, linguini, etc.	☐ Yes ☐ No	
Other pasta?	☐ Yes ☐ No	

Do you have any canned fruits, vegetables, or beans in the home?

Canned fruits		***How much? Number and size of cans?***
(List type)	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
Canned vegetables	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	

Canned beans	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
Any other canned foods?	☐ Yes ☐ No	

Next I want to ask you about any homemade or store-bought desserts that you might have.

Desserts		***How many items? Use package label or count***
Cookies (regular, reduced-fat)	☐ Yes ☐ No	
Cake or cupcakes (regular or reduced-fat)	☐ Yes ☐ No	
Muffins	☐ Yes ☐ No	
Brownies or sweet bars	☐ Yes ☐ No	
Other snack cakes	☐ Yes ☐ No	
Pastry, sweet rolls, donuts	☐ Yes ☐ No	
Other desserts?	☐ Yes ☐ No	

Next, I will ask you about any chips, crackers, or other snack foods you may have.

Chips/Snacks		***How many items? Use package label or count***
Crackers (regular, whole grain, reduced-fat)	☐ Yes ☐ No	
Potato chips (reg. or reduced-fat)	☐ Yes ☐ No	
Corn chips or tortilla chips (reg. or reduced-fat)	☐ Yes ☐ No	
Cheese curls or puffs (reg. or reduced-fat)	☐ Yes ☐ No	
Bagel chips (reg. or reduced-fat)	☐ Yes ☐ No	
Graham crackers	☐ Yes ☐ No	

Pretzels	☐ Yes ☐ No	
Popcorn (pre-popped or microwave bags)	☐ Yes ☐ No	
Peanuts, cashews, other nuts	☐ Yes ☐ No	
Granola bars, sports bars (reg. or reduced-fat)	☐ Yes ☐ No	
Other chips, crackers, or savory snacks?	☐ Yes ☐ No	

Now I want to ask you about any candy or sweet snacks you may have.

Candy/sweet snacks		***How many items? Use package label or count***
Chocolate candy (white, milk, dark)	☐ Yes ☐ No	
Hard candy	☐ Yes ☐ No	
Gummies	☐ Yes ☐ No	
Fruit rollups	☐ Yes ☐ No	
Chewy candy	☐ Yes ☐ No	
Other candy?	☐ Yes ☐ No	

Overall, would you say that the total amount of foods you have in the home currently is greater than usual, about the same, or less than usual?

☐More than usual ☐Less than usual ☐The same

Are there any other foods in the home that we did not already mention? ☐ Yes ☐ No
If NO, *End of survey.*
If YES, *Can you please list those foods to me?*

#1	**Amount:**
#2	
#3	

APPENDIX G

HOME FOOD ENVIRONMENT SURVEY 2

Home Food Environment Telephone Survey (#2)

Interviewer Name:_____ Date:_____

Participant Name:_____ Participant ID:_____

Participant Date of Birth: _____

Interview Start Time: _____ End Time:_____

What week of the month is it? ☐First, ☐Second, ☐Third, ☐Fourth Week

Fast Food Frequency

1. In the last week, how often have you eaten at a fast food restaurant? _____ times

Stress

1. Can you rate your level of stress, in how you felt in general within the last week?

1 2 3 4 5 6 7 8 9 10
Not at all stressed *Somewhat stressed* *Extremely stressed*

2. In terms of your last response for level of stress, can you explain your response? Was there any stress over the amount or variety of food available in the home? _____

_____

_____

_____

_____

First, I am going to ask you about fresh fruits and vegetables you have in the home. Please look in any area of the house or kitchen that you keep fresh fruits and vegetables such as the refrigerator, on counter tops, in cabinets, on the dining table, and other places.

*Do you have any **fresh fruit** in your home?* ☐Yes ☐ No

If YES, *Can you tell me what types of **fresh fruit** you have in the home?*

Fruits		***How much or how many?***
Apples	☐ Yes ☐ No	
Bananas	☐ Yes ☐ No	
Blueberries	☐ Yes ☐ No	

Grapes	☐ Yes ☐ No	
Grapefruit	☐ Yes ☐ No	
Lemons or limes	☐ Yes ☐ No	
Melons (ie. Watermelon)	☐ Yes ☐ No	
Nectarines	☐ Yes ☐ No	
Oranges	☐ Yes ☐ No	
Pears	☐ Yes ☐ No	
Peaches	☐ Yes ☐ No	
Strawberries	☐ Yes ☐ No	
Tangerines/clementines	☐ Yes ☐ No	
Others?	☐ Yes ☐ No	

*Do you have any other **fresh fruits** that I did not ask about, in your home? Maybe in the cabinets, or in the fridge?* ☐ Yes ☐ No

Others:	**Amount:**

Now I am going to ask you about the fresh vegetables you have in the home. Please look anywhere you generally keep fresh vegetables such as the refrigerator, in cabinets, on countertops, or other places.

*Do you have any **fresh vegetables** in your home?* ☐Yes ☐No

If YES, *Can you tell me what types of **fresh vegetables** you have in the home?*

Vegetables		***How much, or, how many?***
Asparagus	☐ Yes ☐ No	

Beets	☐ Yes ☐ No	
Bell Peppers (any color)	☐ Yes ☐ No	
Broccoli	☐ Yes ☐ No	
Cabbage	☐ Yes ☐ No	
Cauliflower	☐ Yes ☐ No	
Carrots	☐ Yes ☐ No	
Celery	☐ Yes ☐ No	
Corn	☐ Yes ☐ No	
Cucumbers	☐ Yes ☐ No	
Green beans	☐ Yes ☐ No	
Lettuce	☐ Yes ☐ No	
Mushrooms	☐ Yes ☐ No	
Peas	☐ Yes ☐ No	
Potatoes	☐ Yes ☐ No	
Spinach (or other greens)	☐ Yes ☐ No	
Squash	☐ Yes ☐ No	
Sweet Potatoes	☐ Yes ☐ No	
Tomatoes	☐ Yes ☐ No	
Others?	☐ Yes ☐ No	

*Do you have any other **fresh vegetables** in your home? Maybe in the cabinets, or in the fridge?* ☐Yes ☐No

Others:	**Servings/Amount:**

Do you have a refrigerator in the home? ☐ Yes ☐ No

If YES, *Now I'm going to ask you about the types of foods you have inside the fridge. First, do you have any cheeses in the fridge?* ☐ Yes ☐ No

Cheeses		***How much? (Package label or estimation)***
Block	☐ Yes ☐ No	
Shredded	☐ Yes ☐ No	
Sliced	☐ Yes ☐ No	
String cheese	☐ Yes ☐ No	
Ricotta or cottage cheese	☐ Yes ☐ No	
Cream cheese, Neufchatel	☐ Yes ☐ No	
Cheez whiz, velveeta, or other canned cheese	☐ Yes ☐ No	
Other?	☐ Yes ☐ No	

Next, I want to ask if you have any other dairy products in the home? ☐ Yes ☐ No
If YES, *Can you check the places where you keep dairy products such as the refrigerator or freezer?*

Other Dairy Products		***How much? (Package label or estimation)***
Milk (specify % fat)	☐ Yes ☐ No	
Half and half or heavy cream	☐ Yes ☐ No	
Yogurt or yogurt drinks	☐ Yes ☐ No	
Other?	☐ Yes ☐ No	

Now I'm going to ask you about the different fats or oils you may have in the home. Can you please look around in the cabinets, on the countertop, and in the fridge for these items?

Fats and Oils		***How much? (refer to package label or portion estimate)***
Butter (regular or light)	☐ Yes ☐ No	
Margarine	☐ Yes ☐ No	
Lard or shortening	☐ Yes ☐ No	
Oils (specify type) Olive, canola, vegetable, coconut	☐ Yes ☐ No	
Other?	☐ Yes ☐ No	

Next I'm going to ask you about different meats you may have in the home. Can you look in the fridge or freezer for these items?

Meats		***Specific type of meat?***	***Amount? (package label or portion estimate)***
Deli meats Sliced turkey or chicken	☐ Yes ☐ No		
Sliced bologna, salami	☐ Yes ☐ No		
Sliced ham, beef	☐ Yes ☐ No		
Sausage, pepperoni	☐ Yes ☐ No		
Bacon	☐ Yes ☐ No		
Hot dogs, bratwurst	☐ Yes ☐ No		
Ground beef (regular, lean, extra lean)	☐ Yes ☐ No		
Pork (pork roast or pork chop)	☐ Yes ☐ No		

Chicken (with or without skin) (specify: pieces, "legs, wings, breasts, etc.")	☐ Yes ☐ No		
Turkey (with or without skin) (specify pieces)	☐ Yes ☐ No		
Others?	☐ Yes ☐ No		

Was that all the different meats you have in the home in both the fridge and the freezer? ☐ Yes ☐ No

If NO, *What other meats are there in the home that we did not already mention?*

Others?	☐ Yes ☐ No	***Type?***	***Amount?***

Next, I want to ask you about fish and other types of protein that you may have in the home. Can you please look in the fridge, freezer, and cabinets for these items?

Fish & Other Protein		***Specific type?***	***How much or how many? (package label portion estimate, or count)***
Fish	☐ Yes ☐ No		
Shellfish	☐ Yes ☐ No		
Tofu, tempeh	☐ Yes ☐ No		
Beans, Lentils	☐ Yes ☐ No		
Eggs	☐ Yes ☐ No		
Peanut Butter (or other nut butter)	☐ Yes ☐ No		
Nuts	☐ Yes ☐ No		
Other Protein?	☐ Yes ☐ No		

Do you have any foods that are already prepared such as mixed dishes? Think of things like casseroles, soups, or other combination dishes. Please look for these items in the fridge, freezer, or cabinets.

Prepared foods/Mixed Dishes		***Can you describe the amount using portion sizes or package labels?***
Type/Major Ingredients:	☐ Yes ☐ No	
Type/Major Ingredients:	☐ Yes ☐ No	
Type/Major Ingredients:	☐ Yes ☐ No	
Others?	☐ Yes ☐ No	

Next I want to know what types of beverages you have in the home. Can you look for these in the fridge, on the countertops, in cabinets, or anywhere else you may keep these items?

Beverages		***Specific type?***	***Amount? Refer to package label or portion size.***
Sodas	☐ Yes ☐ No		
Iced tea, lemonade	☐ Yes ☐ No		
100% Fruit juice	☐ Yes ☐ No		
Other fruit Juice drinks (such as Cool-aid, sunny delight etc.)	☐ Yes ☐ No		
Sports drinks	☐ Yes ☐ No		
Other drinks? (such as red bull)	☐ Yes ☐ No		

I've asked you about some things you might keep in the freezer but I want to know if you have any of these other frozen foods.

Desserts		***Specific type?***	***How much or how many? (package label portion estimate)***

Sherbet, sorbet	☐ Yes ☐ No		
Fruit juice bars, popsicles	☐ Yes ☐ No		
Rice or soy desserts	☐ Yes ☐ No		
Ice cream	☐ Yes ☐ No		
Other frozen dairy products (ie. Custard, yogurt):	☐ Yes ☐ No		
Other desserts:	☐ Yes ☐ No		
Microwaveable/Quick-Cook Foods:			
Pizza	☐ Yes ☐ No		
Hot Pockets	☐ Yes ☐ No		
Pizza Rolls, bagel bites	☐ Yes ☐ No		
Burritos, taquitos, etc.	☐ Yes ☐ No		
French fries, tater tots, hashbrowns	☐ Yes ☐ No		
Egg rolls, Asian food items	☐ Yes ☐ No		
Chicken nuggets	☐ Yes ☐ No		
Other quick-cook:	☐ Yes ☐ No		

Are there any frozen fruits or vegetables in the freezer? ☐ Yes ☐ No
If YES, *Can you tell me more about the frozen fruit and/or vegetables. What types do you have?*

Frozen fruits or vegetables	***How much or how many do you have?***
(list items)	

Is there any other food in the freezer that you did not mention already? ☐ Yes ☐ No
If YES, *Can you please tell me which foods in the freezer we did not cover?*

Other frozen foods:	

Is there any other food in the fridge that you did not mention already? ☐ Yes ☐ No
If YES, *Can you please tell me which foods in the fridge we did not cover?*

Other fridge foods:	

Now that we have covered all the foods that are kept in the fridge and freezer, I want to ask you about foods that do not need to be stored cold/frozen. These foods may be in your cabinets, pantry, on counter tops, or other places.
First, do you have any bread products? ☐ Yes ☐ No

Bread		***How many slices or items? Use package label or count***
Wheat bread or rolls	☐ Yes ☐ No	
White bread or rolls	☐ Yes ☐ No	
English muffins (wheat or white)	☐ Yes ☐ No	
Bagels (wheat or white)	☐ Yes ☐ No	
Tortillas (wheat, flour, corn)	☐ Yes ☐ No	

Pita bread (wheat or white)	☐ Yes ☐ No	
Croissants or baked breads (ex. biscuits)	☐ Yes ☐ No	
Other breads?	☐ Yes ☐ No	

Now I want to ask you about any cereals, rice, or pasta you might have.

Cereals, rice, pasta		***How much or how many servings?***
Corn flakes	☐ Yes ☐ No	
Rice cereals	☐ Yes ☐ No	
Bran cereal	☐ Yes ☐ No	
Chocolate cereals	☐ Yes ☐ No	
Fruit flavored cereal	☐ Yes ☐ No	
Other cereals?	☐ Yes ☐ No	
Rice (white, brown, yellow)		
Quinoa, bulgar, barley	☐ Yes ☐ No	
Other dried grain products?	☐ Yes ☐ No	
Pasta (whole wheat, white) Spaghetti, macaroni, penne, linguini, etc.	☐ Yes ☐ No	
Other pasta?	☐ Yes ☐ No	

Do you have any canned fruits, vegetables, or beans in the home?

Canned fruits		***How much? Number and size of cans?***
(List type)	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	

	☐ Yes ☐ No	
	☐ Yes ☐ No	
Canned vegetables	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
Canned beans	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
	☐ Yes ☐ No	
Any other canned foods?	☐ Yes ☐ No	

Next I want to ask you about any homemade or store-bought desserts that you might have.

Desserts		***How many items? Use package label or count***
Cookies (regular, reduced-fat)	☐ Yes ☐ No	
Cake or cupcakes (regular or reduced-fat)	☐ Yes ☐ No	
Muffins	☐ Yes ☐ No	
Brownies or sweet bars	☐ Yes ☐ No	
Other snack cakes	☐ Yes ☐ No	
Pastry, sweet rolls, donuts	☐ Yes ☐ No	
Other desserts?	☐ Yes ☐ No	

Next, I will ask you about any chips, crackers, or other snack foods you may have.

Chips/Snacks		***How many items? Use package label or count***
Crackers (regular, whole grain, reduced-fat)	☐ Yes ☐ No	
Potato chips (reg. or reduced-fat)	☐ Yes ☐ No	
Corn chips or tortilla chips (reg. or reduced-fat)	☐ Yes ☐ No	
Cheese curls or puffs (reg. or reduced-fat)	☐ Yes ☐ No	
Bagel chips (reg. or reduced-fat)	☐ Yes ☐ No	
Graham crackers	☐ Yes ☐ No	
Pretzels	☐ Yes ☐ No	
Popcorn (pre-popped or microwave bags)	☐ Yes ☐ No	
Peanuts, cashews, other nuts	☐ Yes ☐ No	
Granola bars, sports bars (reg. or reduced-fat)	☐ Yes ☐ No	
Other chips, crackers, or savory snacks?	☐ Yes ☐ No	

Now I want to ask you about any candy or sweet snacks you may have.

Candy/sweet snacks		***How many items? Use package label or count***
Chocolate candy (white, milk, dark)	☐ Yes ☐ No	
Hard candy	☐ Yes ☐ No	
Gummies	☐ Yes ☐ No	
Fruit rollups	☐ Yes ☐ No	
Chewy candy	☐ Yes ☐ No	
Other candy?	☐ Yes ☐ No	

Overall, would you say that the total amount of foods you have in the home currently is greater than usual, about the same, or less than usual?

☐More than usual ☐Less than usual ☐The same

Are there any other foods in the home that we did not already mention? ☐ Yes ☐ No
If NO, *End of survey.*
If YES, *Can you please list those foods to me?*

#1	**Amount:**
#2	
#3	
#4	
#5	

APPENDIX H

JSNN MRI SCREENING FORM

Operator Scanning Check List

PI/IRB #: _____ Acrostic: _____ Date: _____

To be filled out by PI or Study Coordinator:

Acrostic for Last Name Field : _____

Participant ID : _____

Accession Number : _____

Date and Time : _____

Height: _____ **Weight:** _____ **Birth Year:** _____ ☐ **Male** ☐ **Female**

⚠ MRI utilizes a very strong magnetic field, rapidly switching gradient magnetic fields and powerful radiofrequency transmissions. While having an **MRI is safe for most people, there are a number of instances when it can be dangerous (even fatal) for someone to have an MRI exam.** This screening form is used to identify which individuals can safely have an MRI exam.

Absolute Contraindications:

1.	☐ Yes	☐ No	Do you have a heart pacemaker?
2.	☐ Yes	☐ No	Is there a possibility of metal in your head? (e.g. aneurysm clips, metal ear tubes, etc.) for this question exclude dental work)
3.	☐ Yes	☐ No	Is there a possibility of metal in your eyes, have you ever needed an eyewash while working with metals, have you ever had an injury to the eye involving a metal object or fragment (e.g., metallic slivers, shavings, foreign body, etc.)
4.	☐ Yes	☐ No	Do you have any implanted medical devices in your body? (cochlear implant, metal ear tubes, bone stimulator, neurostimulator, biostimulator, medication pump, automatic defibrillator, internal pacing wires, etc). Exclude orthopedic hardware and dental work
5.	☐ Yes	☐ No	Do you have any implants held in by a magnet (dentures, posts, or crowns)?
6.	☐ Yes	☐ No	Have you had any bone, tendon, spine, or dental surgery **within the last 6 weeks**?
7.	☐ Yes	☐ No	Do you weigh more than 450 pounds (181 kg)?
8.	☐ Yes	☐ No	Are you pregnant or suspect you may be pregnant?

⚠ If you checked **Yes** to any of the questions above you do not need to complete the rest of the form. **You cannot enter the MRI Exam room under any circumstances** until you are able to answer No to all of these questions.

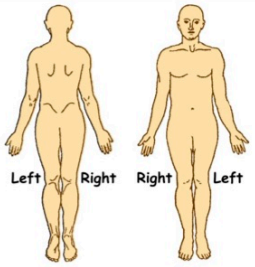
Operator Scanning Check List

PI/IRB #: _____ Acrostic: _____ Date: _____

Potential Contraindications:

9.	☐ Yes ☐ No	Do you have an IUD that may contain copper, or a contraceptive diaphragm?
10.	☐ Yes ☐ No	Have you had any stents, clips or surgery to any of any of your vessels (carotid artery vascular clamp, coronary stent, aortic clips, IVC filter, coils for blocked arteries)
11.	☐ Yes ☐ No	Do you have metal anywhere else in your body? (screws, pins, plates, spinal rods, dental work - not including fillings and caps, piercings, shrapnel, buckshot, bullets) – please indicate where on your body on the diagram above.
12.	☐ Yes ☐ No	Do you have a cerebrospinal fluid (CSF) shunt? (treatment for hydrocephalus or water on the brain)
13.	☐ Yes ☐ No	Do you have any piercings that can't be removed?
14.	☐ Yes ☐ No	Do you have a transdermal medicated patch? (nicotine patch, contraceptive patch, medicated pain relief patch)
15.	☐ Yes ☐ No	Have you had any medical condition that has prevented you completing an MRI exam in the past?
16.	☐ Yes ☐ No	Do you wear a prosthetic device?
17.	☐ Yes ☐ No	Have you had any previous surgery? (give details, and indicate where on your body using the diagram below)

Details:



If you have answered **Yes** to any of the questions 10 through 19 then we need additional information and documentation before you may have your MRI exam. If possible, the items resulting in a Yes answer should be removed before your MRI exam. If this is impossible, the Principle Investigator/Study Coordinator needs to provide additional information that your device is MRI safe before you enter the MRI exam room.

Notes:

Operator Scanning Check List

PI/IRB #: _____ Acrostic: _____ Date: _____

Precautions:

18.	☐ Yes ☐ No	Do you have tattooed eyeliner, tattooed eyebrows or hair dye?
19.	☐ Yes ☐ No	Do you have any tattoos? If yes, where?
20.	☐ Yes ☐ No	Are you wearing a wig or hair extensions?
21.	☐ Yes ☐ No	Do you have any problems when you lie flat on your back? (breathing problems, back pain, nausea, etc.)
22.	☐ Yes ☐ No	Do you take beta blockers, sedatives, or diuretics?
23.	☐ Yes ☐ No	Do you have a fever?
24.	☐ Yes ☐ No	Are you wearing a hearing aid or dentures?
25.	☐ Yes ☐ No	Do you suffer from claustrophobia?

If you have answered **Yes** to questions 18-24 then you may have an MRI today but we want to take a moment to provide you with some additional instructions. Please remove your hearing aid and/or dentures (along with all other metal) before entering the MRI scanner. MRI uses radio waves to make a picture. These radio waves are perfectly safe but under certain circumstances may make you feel warm. This can occur locally, for example at the site of a tattoo, or over your entire body. If this happens please let the operator know immediately -- even if the MRI scanner is making a large knocking noise.

Before entering the MR environment or MR system room, you **must remove ALL metallic objects** including hearing aids, dentures, partial plates, keys, cell phones, eyeglasses, hairpins, barrettes, jewelry, body piercings, credit cards, clothing with metal fasteners, & clothing with metal or metallic threads. **Please consult the MRI Operator if you have any questions or concerns BEFORE you enter the MR Exam room.**

I attest that the above information is correct to the best of my knowledge. I have read and understand the contents of this form and had the opportunity to ask questions regarding the information on this form and regarding the MR procedure that I am about to undergo.

Signature of Person Completing Form: _____
Signature and Date

Form Completed By:

☐ Participant ☐ Other _____
If other, print name and relationship to participant

Reviewed By MRI Operator: _____
Print name, signature, and date

Operator Scanning Check List

PI/IRB #: _____ Acrostic: _____ Date: _____

To be filled out by MRI Operator:

MRI Operator Pre-Entry checklist …

⚠ If the subject entered **Yes** to any of the questions above **the participant cannot enter the MRI scanner under any circumstances**

1.	☐	Review screening form.
2.	☐	Do you have any questions or concerns about the questions on this form?
3.	☐	Do you have anything in your body that wasn't there when you were born?
4.	☐	Have you ever had an MRI before? Be careful with this question, many people don't know the difference between an MRI scan and a CT scan.

Certify that there are no absolute contraindications to MRI

1.	☐ Yes	☐ No	Do you have a heart pacemaker?
2.	☐ Yes	☐ No	Is there a possibility of metal in your head? (e.g. aneurysm clips, metal ear tubes, etc.) Exclude dental work.
3.	☐ Yes	☐ No	Is there a possibility of metal in your eyes, have you ever needed an eyewash while working with metals, have you ever had an injury to the eye involving a metal object or fragment (e.g., metallic slivers, shavings, foreign body, etc.)
4.	☐ Yes	☐ No	Do you have any implanted medical devices in your body?
5.	☐ Yes	☐ No	Do you have any implants held in by a magnet (dentures, posts, or crowns)?
6.	☐ Yes	☐ No	Have you had surgery **within the last 6 weeks**?
7.	☐ Yes	☐ No	Do you weigh more than 450 pounds (181 kg)? (Only ask if unsure)
8.	☐ Yes	☐ No	Are you pregnant or suspect you may be pregnant? (Obviously, females only)

Last minute checks

☐ Use Restroom	☐ Cell phone / pager	☐ Hair pins/barrettes
☐ Pockets empty?	☐ Metal Buttons	☐ Wig/Hair extensions
☐ Keys / coins	☐ Clothing with metal	☐ Hearing aid
☐ Wallet / money clip	☐ Shoes with metal	☐ Removable dentures
☐ Watch / Jewelry	☐ Belt	☐ Nicotine or other patch
☐ Glasses	☐ Piercings	☐ Magnetic implants

MRI Operator Initials: _____

Operator Scanning Check List

PI/IRB #: _____ Acrostic: _____ Date: _____

Operator final Prescan checklist …

⚠
- ☐ Hang MRI Use Sign on MRI Suite Door
- ☐ Earplugs in place and working
- ☐ Participant given call ball with instructions on how to use
- ☐ Confirm that participant is comfortable and can communicate via patient monitoring system.

MRI Operator Initials: _____

Operator final Post Exam checklist …

- ☐ Ask participant if there were any sensations of **tingling and/or heating** during the exam that were uncomfortable or caused him/her concern. **If yes, Operator must fill out these questions**

- ☐ Ask participant if there hands were clasped and/or feet crossed during when the tingling and/or heating occurred.

- ☐ PI, Acrostic, and Date completed on every page of screening form.
- ☐ PI, Acrostic, and Date completed on every page of Operator Check List form.

- ☐ Data has been archived (transferred to the UNCG PACS, burned to CD/DVD, copied to flash drive)
- ☐ Copy of images given to participant.
- ☐ Clean table, pads, headphones, and coil with disinfectant.
- ☐ Place head coil on table.
- ☐ Return table to home position
- ☐ Close out patient on system console.
- ☐ Remove MRI In Use sign from MRI Suite door.

Notes:

MRI Operator Initials: _____

Operator Scanning Check List

PI/IRB #: _____ Acrostic: _____ Date: _____

Notes on potential contraindications to MRI:

The UNCG Gateway screening form is broken up into three sets of questions.

- **Questions 1-8** are all absolute contraindications for having an MRI at Gateway. Participants that answer Yes to any of these questions may not have an MRI exam at Gateway.

- **Questions 9-17** are potential contraindications for having an MRI exam at Gateway. If a participant answers yes to any of these questions either additional information is needed before the participant may undergo an MRI exam at Gateway or the item in question must be removed before the participant enters the MRI Exam room. Implanted devices that cannot be removed must be looked up in the Shellock guide or the online list (http://www.mrisafety.com/list_search.asp). In order for a person to be scanned at Gateway with an implanted device three conditions must be met. **First**, the exact make, model, and manufacturer of the implanted device must be documented. **Second**, the exact make and model of the implanted device must be approved for scanning in a 3T magnetic field in either the Shellock guide or Shellock's online list. **Third**, the documentation of the device and approval by either the Shellock guide or online list must be reviewed and approved by a certified Gateway operator that is not involved in the study.

- **Questions 18-25** are intended to give the operator more information about the participant and how best to make the MRI a safe and as pleasant experience as possible. For example, questions concerning tattoos let the operator know that the participant should be informed of the potential heating issues with tattoos and the participant should let the operator know if he/she experiences any heat in the area of the tattoo.

Information about each specific question is below

Q3. Metal Fragments in Eyes

Metal fragments in the eye are a serious concern. Even if the magnetic fragments are small the main magnetic field can cause these metal fragments to move and cause permanent damage to the eye. For clinical MRIs, the standard of care is to order a high resolution CT or orbital X-rays to rule out the possibility of metal fragments in the eye. Since this is not possible for subjects undergoing an research MRI exam at Gateway, subjects with the potential of metal in their eye are excluded from participating in the study.

Q7. 450lb patient limit

The patient table has a limit of 550lbs. The 450lb limit is established to provide some margin of error when scanning larger participants. Even though the patient table may support the weight of a larger person, the person may not fit in the scanner. Operators should be aware that there are special considerations when scanning larger participants. Larger patients require more RF power for MRI scanning and will experience higher Specific Absorption Rates then average sized participants. Protocols that are setup for average size participants may not function without modifications. Larger size patients may come in contact with the sides of the scanner bore. This increases the chance of burns so padding should be placed between the participant and the scanner bore to minimize this risk. Operators should also understand that in the event of a medical emergency it is important that the participant should be removed from the MRI exam room. If this is not possible, operators must control access to the MRI exam room when additional help arrives.

Q8. Pregnancy
MRIs are considered safe for pregnant women and the fetus but there are minor concerns with tissue heating due to exposure to radio waves. An MRI exam of a pregnant woman is prescribed when there is a direct benefit to either the mother or the fetus. In the research environment where there is no direct benefit to the participants pregnant women, as determined from self reporting, are excluded from all research studies at Gateway unless one has specific IRB approval to scan women who answer yes to this question.

Q9. Copper-containing IUD, or diaphragm
Older IUD contraceptives containing copper are safe at 1.5T but untested at 3T. **You must identify the exact device that the subject has and it must be listed as safe at http://www.mrisafety.com/.**
Diaphragms containing a metal ring may get hot (remove before scan).

Q10. Metal associated with vessels
There is a potential danger of ferromagnetic hardware being displaced by the strong magnetic field. Coronary (heart) stents are MRI safe. Most carotid (neck) vascular clamps are safe at 1.5T (except Poppen-Blaylock clamp) but untested at 3T. Stents become firmly attached to tissues, and are unlikely to move beyond first few months. More details are needed before proceeding. **You must identify the exact device that the subject has and it must be listed as safe at http://www.mrisafety.com/**

Q11. Other metal in the body
Metal bullets/shot/shrapnel in the head or torso are a contraindication to MRI. The only exception to this is implanted dental work in place for more than 6 weeks. Longstanding immobile bullets/shot/shrapnel in bones in the limbs are not a contraindication. Spinal rods or intramedullary rods older than 6 weeks are not a contraindication to MRI, but in these cases images quality may be significantly degraded depending on location. Piercings should be removed (or see below).

Q12. CSF shunts
Most are MRI safe – but some are programmed magnetically, and subjects will need the unit to be reprogrammed by their doctor after MRI. More details are needed before proceeding. **You must identify the exact device that the subject has and it must be listed as safe at http://www.mrisafety.com/**

Q13 Non-removable piercings
We recommend that subjects should not be scanned with piercings in place as there is a small risk of heating, vibration or discomfort. If not removable and non-magnetic (test with magnet in workshop) and it is deemed important to proceed with the MRI, scanning may be OK – but immobilize piercing with tape and insulate as much as possible from skin (at least 1cm insulation to prevent burns). Remain in close verbal and visual contact with subject. Warn subject about pain, heating, and possible vibration of piercing. Any unpleasant sensations / adverse reaction must be reported to IRB.

Q14. Transdermal delivery patch (e.g. nicotine, contraceptive or medicated pain relief patch)
These may cause local heating. Remove before MRI

Q15. Prior problems completing a MRI exam
This question is an opportunity to find out about potential medical problems or contraindications to MRI that

subjects forgot to mention in earlier questions.

Q16. Prosthetic Devices

Prosthetic devices should be removed before entering the MRI exam room. Gateway does not have an MR compatible wheel chair. Operators will need to plan accordingly when helping the participant walk to the patient table.

Q17. Previous surgery.

This question is an opportunity to find out about metal in the body that subjects failed to mention in questions 10,11, or 12. Surgeries are not necessarily contraindications but subjects should wait at least six weeks if there is a possibility of an implanted device becoming dislodged. If no devices were implanted during the surgery then the participant is safe to be scanned. If the screener is unfamiliar with the surgery then additional questions should be asked before allowing the participant to be scanned.

Q18. Tattooed eyeliner, tattooed eyebrows or Bigen hair dye

May cause local heating and distortion of the MR images. Scanning may be unproblematic – but remain in close visual and verbal contact with subject Warn subject about pain, heating, tactile sensations in the tattoo (and complete a peripheral nerve stimulation form if tactile sensations are experienced). Any unpleasant sensations / adverse reaction must also be reported to IRB.

Q19. Tattoos

Participants may experience local heating. The further the tattoo is located outside the bore the less likely local heating will be a problem. Even though the risk of local heating is low remain in close visual and verbal contact with subject. Warn subject about pain, heating, tactile sensations in the tattoo (and complete a peripheral nerve stimulation form if tactile sensations are experienced).). Any unpleasant sensations / adverse reaction must also be reported to IRB.

Q20. Wigs and hair extensions

Q21. Difficulty lying supine

Subjects with medical conditions that are exacerbated when they lie flat are unlikely to be able to complete a MRI exam. If symptoms are severe enough to hamper communication (e.g. very breathless subject), then they should not undergo MRI. If symptoms are mild, then it is OK to proceed, but remain in close verbal and visual contact with the subject. Keeping the exam short will help.

Q22. Beta blockers, sedatives, and diuretics

These types of drugs may compromise a person's ability to regulate their body temperature during the exposure to the RF magnetic field. These types of medication are not a contraindication for MRI but we are asking that the operator verify with the participant that they are comfortable during the exam and are not over heating.

Q23. Fever

If a person has a fever then a person's ability to regulate their body temperature during the exposure to

the RF magnetic field may be impaired. Scanning a person with a fever is not a contraindication but should the operator verify with the participant that they are comfortable during the exam and are not over heating.

Q24. Hearing aids & dentures (and removable bridge)
Remove before MRI. Hearing aids that are implanted and cannot be removed are a contraindication to MRI exam. There is a minor risk of injury as these objects are turned into projectiles. In addition, hearing aid may no longer function after exposure to main magnetic field. Dentures and removable bridges may experience local heating during the MRI exam and may create significant image artifacts that will render the data worthless.

Q25. Claustrophobia
Subjects with claustrophobia will require additional training and encouragement to complete their MRI exam. Keeping the exam very short will help. Claustrophobic subjects who have been unable to complete MRI exams in the past remain unlikely to complete them in the future.